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XXXI (1945)

PART II: ZOOLOGY

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VOLUME XXXI (1945)

PART II: ZOOLOGY

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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

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VOLUME XXXI (1945)
PART II: ZOOLOGY

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

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ZOOLOGY

THE MALE ALLOTYPE AND FEMALE HYPOTYPE OF *STORENA BARROANA* (CHAMBERLIN)

ARTHUR M. CHICKERING

AMONG the spiders, Zodariidae were unknown in Panama until the year 1925, when Professor Chamberlin described an immature female as *Naibena barroana*. The Cambridges (1889–1905) recognized two genera and three species from Guatemala and Mexico. One of these was thought to have been ascribed to Mexico through an error. Mr. Banks (1929) collected a single female of Chamberlin's species in the Canal Zone Biological Area and transferred the species to the genus *Storena*. He also changed the original spelling of the specific name because he believed that a typographical error had been made. Williams (1941) listed *Storena barroana* (Chamberlin) among the animals collected on the forest floor of the Canal Zone Biological Area. The Arachnida from Dr. Williams' collection were identified by Dr. W. J. Gertsch, American Museum of Natural History, New York City.

In view of the fact that Chamberlin's original description was very brief and was based upon an immature female which, according to a personal communication from Miss E. B. Bryant, Museum of Comparative Zoölogy, Harvard College, was "probably two moults from maturity," I have considered it desirable to establish a male allotype and a female hypotype from fully mature specimens, of which I have a plentiful supply in my collection. The species remains the only known zodariid from Panama.

In his recently revised definition of the Zodariidae Petrunkevitch (1939) has included the following characters among the fundamental features of the family: absence of a basal cheliceral boss; "trichobothria few, in two rows on tibiae, in one row on tarsi and metatarsi"; trochanters slightly notched. In *Storena barroana* (Chamberlin) the following features appear: basal cheliceral boss well developed in both sexes; the single dorsal series of trichobothria clearly visible on tarsi and metatarsi; the same also true of the double dorsal series of

trichobothria on tibiae; short slender erect hairlike structures at least much similar to those regarded as trichobothria by Petrunkevitch also occur irregularly distributed on all these segments and probably also on patellae; ventral trochanteral notches visible on males and not detectable on females.

Male allotype. — Total length 4.86 mm. Carapace 2.52 mm. long, 1.73 mm. wide opposite second coxae, where it is widest, bluntly rounded in front; posterior row of eyes occupying about three fifths of width of head at their level; with well-defined longitudinal thoracic groove beginning about one third of distance from posterior border; with three pairs of moderately well marked thoracic striae radiating from thoracic groove; tallest opposite attachment of palps, where it is 1.02 mm. tall; steep posterior declivity gently arched to posterior border (Figs. 1–2); with scattered short black bristles; surface finely bearded, especially along lateral sides.

Eyes. — Eight in two rows. Posterior row longer than anterior row in ratio of about 17 : 11. All eyes more or less surrounded by black pigment; anterior medians dark, all others light-colored. Viewed from in front, both rows moderately procurved. All eyes small. Ratio of eyes AME : ALE : PME : PLE = 3 : 4.3 : 4.3 : 5. AME separated from one another and from ALE by about their diameter. PME separated from one another by their radius, from PLE by about eight fifths of their diameter. Laterals separated by about the diameter of PLE. Central ocular quadrangle wider behind than in front in ratio of 11.5 : 9, longer than wide behind in ratio of 13 : 11.5. Width of clypeus equal to about nine diameters of AME.

Chelicerae. — Short, moderately stout, vertical, parallel; with distinct basal boss; with short fang, evenly curved; margins wholly devoid of teeth (observed on paratype to avoid injury to allotype); promargin with well-developed scopula of long stiff black hairs.

Maxillae. — Longer than wide in middle in ratio of about 5 : 2; gently tapered distally; distinctly convergent; palp inserted near base; with well-developed terminal scopulae.

Lip. — Nearly triangular; wider at base than long in ratio of about 4 : 3; about one fourth as wide at distal end as at base; reaches about three fourths of the length of maxillae. Sternal suture somewhat recurved. Broadly notched at basal lateral corners.

Sternum. — Cardioform; slightly widest between first coxae, but nearly as wide between second coxae; anterior border wider than

EXTERNAL ANATOMY OF *STORENA BARROANA* (CHAMBERLIN)

1. Carapace, lateral view
2. Whole animal, dorsal view, legs removed
3. Palpal patella, tibia, and tarsus, ventral view
4. Palpal tibia and tarsus, retrolateral view
5. Epigynum, ventral view
6. Epigynum, posterior view
7. Spermathecae and associated tubules, dissected

base of lip in ratio of about 2 : 1; mildly convex; posterior end sharply pointed but not extended between fourth coxae, which are separated by about one fourth of their diameter. All coxae moderately elongated.

Legs. — 4123. Tibial index of first leg 11, of fourth leg 13.

	Femora	*Patellae*	*Tibiae*	*Metatarsi*	*Tarsi*	*Totals*
	(All measurements in millimeters)					
1.	1.73	0.64	1.48	1.57	1.09	6.51
2.	1.44	0.64	1.09	1.28	0.96	5.41
3.	1.28	0.64	1.03	1.60	0.83	5.38
4.	1.66	0.71	1.47	2.22	1.08	7.14
Palp	0.94	0.38	0.26	...	0.90	2.28

Width of first patella at knee 0.244 mm.; width of fourth patella at knee 0.288 mm. First and second femora somewhat prolaterally curved.

Spines. — First leg: femur dorsal 0–1–1–1, prolateral only distal 1, retrolateral only distal 1, ventral 0; patella 0; tibia dorsal 1 (long, slender)–0–0, prolateral 0–0–1, retrolateral 0, ventral 2–1r–2; metatarsus only prolateral 0–0–1, ventral 2–2–2. Second leg: femur and patella as in first; tibia dorsal as in first, prolateral 0–1–1, retrolateral 0, ventral 1r–1r–2; metatarsus prolateral 0 1 1, ventral 0–2–1r–2. Third leg: femur dorsal 0–0–1–1, prolateral 1–0–1, retrolateral 0–0–1–1, ventral 0; patella dorsal 0–1, prolateral 1–1–0, retrolateral 0–1–0, ventral 0; tibia dorsal 1–1–1, prolateral and retrolateral 0–1–1, ventral 2–1p–2; metatarsus dorsal 1–1–0, prolateral 0–2–2, retrolateral 0–1–1–2, ventral 0 2–2–2. Fourth leg: femur and patella as in third except femur dorsal 0–1–1–1; tibia as in third except ventral 2–2 (irregular)–2; metatarsus dorsal 1–1–0, prolateral 1–1–1–2, retrolateral 1–1–2. Palp: femur only dorsal 0–1–1; patella only prolateral 0–1–0; tibia only prolateral, two long slender spines near middle; tarsus only two terminal.

Claws. — Three tarsal claws throughout; proclaw pectinate in a single row with ten moderately stout teeth; retroclaw pectinate in a single row with eleven moderately stout teeth; middle claw simple, without teeth. With no claw tufts.

Palp. — Femur moderately curved prolaterally; both patella and tibia short with body of latter about two thirds as long as patella.

Tibia with a strongly chitinized retrolateral apophysis, broad at base, pointed distally and articulated with a long bladelike tarsal process, and also with a short strongly chitinized peg directed ventrally from base of large retrolateral apophysis. When viewed obliquely retrolateral apophysis is seen to be notched ventrally in middle and distally hooked. Tarsus massive, broad and deep at base; embolus arises at base of bulb on prolateral side, extends along this side as a conspicuous tube and turns to retrolateral side obliquely across distal end of tarsus (Figs. 3–4).

Abdomen. — Regularly ovoid; longer than wide in ratio of about 3 : 2; widest slightly behind middle; well supplied with short black recurved hair; in region where epigynum occurs in female is a small plate suggesting an immature structure of this kind; anal tubercle a short broad yellowish white cone. Three pairs of spinnerets; anterior pair most robust with middle pair smallest (merely slender tubes, easily overlooked); small tracheal spiracle, well chitinized, near base of anterior spinnerets; with a moderately developed low tubercle just anterior to spiracle. A fold at some distance in front of spiracle suggests a migrant spiracle, but must not be mistaken for one. With spinnerets distended from bases; a small group of four short black bristles marks position of vestigial colulus.

Color in alcohol. — Carapace a rich light reddish brown with a broad, nearly black marginal band having an irregular dorsal margin and extending from opposite palps to posterolateral corner. Except the coxae, which are almost white, legs, mouth parts and sternum different shades of amber. Abdomen a rich, dark reddish brown dorsally and dorsolaterally; with three pairs of dorsal whitish spots each containing several white guanin granules, and two median dorsal similar spots in posterior quarter; venter yellowish white with reddish-brown markings: a faintly outlined narrow bar follows genital groove and opposite lung apertures turns backward for a short distance; a narrow central stripe extends from this bar to base of spinnerets; an oblique bar extends on each side to connect the dorsolateral reddish-brown area to the area near base of spinnerets.

Female hypotype. — Total length 5.89 mm. Carapace 3.10 mm. long, 1.98 mm. wide opposite second coxae, where it is widest, 1.28 mm. tall opposite first coxae, where it is tallest; somewhat more massive than in male, but otherwise essentially very similar to that sex.

Eyes. — Posterior row longer than anterior row in ratio of 43 : 27. Ratio of eyes AME : ALE : PME : PLE = 4 : 5 : 6 : 6.5. All except AME somewhat oval in outline. AME separated from one another and from ALE by about their diameter. PME separated from one another by a little more than their radius, from PLE by nearly twice their diameter. Laterals separated by a little more than the diameter of PLE. Central ocular quadrangle wider behind than in front in ratio of about 13 : 10, longer than wide behind in ratio of about 15 : 13. Width of clypeus nearly equal to nine diameters of AME. Clypeus quite convex.

Chelicerae. — Fairly robust, vertical, essentially parallel, quite convex in front, with numerous black bristles of moderate length covering front surface; promargin seems to have an extremely small tooth near base of fang, but elsewhere margins are indistinct and unarmed. Otherwise essentially as in male.

Maxillae, lip, and sternum. — Essentially as in male.

Legs. — 4132. Tibial index of first leg 13, of fourth leg 14.

	Femora	*Patellae*	*Tibiae*	*Metatarsi*	*Tarsi*	*Totals*
		(All measurements in millimeters)				
1.	1.66	0.70	1.41	1.34	0.96	6.07
2.	1.41	0.70	1.09	1.22	0.83	5.25
3.	1.47	0.75	0.96	1.41	0.83	5.42
4.	1.73	0.83	1.47	2.05	1.15	7.23

Width of first patella at knee 0.288 mm.; width of fourth patella at knee 0.333 mm.

Spines. — First leg as in male except tibia dorsal 0, prolateral 0, and metatarsus ventral 2–1r–2. Second leg as in male except femur retrolateral 0; tibia dorsal 0; ventral 1r–2–2 on right and 1r–1r–2 on left; metatarsus prolateral 0–0–1, ventral 0–2–1r–2. Third leg: femur dorsal 0–0–1–1, prolateral 0–1–0–0, retrolateral 0; patella as in male; tibia essentially as in male; metatarsus dorsal 0–1–1, prolateral 0–1–2, retrolateral 0–1–2, ventral 0–1p–1p–2. Fourth leg: femur dorsal 0-1–1–1, retrolateral 0–0–1; patella as in third; tibia dorsal 1–1–1, prolateral 1–1, retrolateral 1–1, ventral 2–1p–2, metatarsus dorsal 1-1–0, prolateral 1–1–0–2, retrolateral 1–1–0–2, ventral 0–2–2–2. Second, third, and fourth metatarsi with moderately well developed ventral scopulae on distal third of segments. Palpal

spines: femur only dorsal 0–1–1; patella only prolateral 0–1–0; tibia only prolateral 2–1, ventral 0–1r–0; tarsus with eleven stout spines irregularly distributed.

Claws. — Tarsal claws essentially as in male. Palpal claws robust, pectinate in a single row with twelve stout teeth.

Abdomen. — Broadly ovoid; longer than wide in ratio of about 7 : 5; with no indication of a tracheal tubercle as in male. Otherwise essentially as in male.

Epigynum. — With a large epigynal plate bearing an oval opening with a strongly chitinized rim near posterior margin; internally several tubules are visible through chitinized surface; considerably elevated along posterior border (seen only when viewed posteriorly) as shown in Figures 5–6; dissection reveals spermathecal tubules as shown in Figure 7.

Color in alcohol. — Carapace uniformly rich reddish brown except for faint darker bands radiating along poorly defined striae from thoracic groove. Sternum, mouth parts, and legs darker than in male but otherwise very similar to that sex. Abdomen as in male except that the reddish-brown dorsal areas are darker and the reddish-brown ventral markings are broader and better defined than in that sex.

Type locality. — Male allotype from Canal Zone Biological Area, July, 1936. Female hypotype from same region, April–May, 1942. Numerous male and female paratypes from same region: June–July, 1934; June and August, 1936; June, 1939; October–December, 1941; April–May, 1942; July, 1943 — March, 1944. Also from Porto Bello, August, 1936, and El Valle, R. P., July, 1936. The species has been taken in large numbers in a Berlese funnel in the Canal Zone Biological Area by Dr. James Zetek.

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THE GENERA *APHILANTHOPS, OCLOCLETES,* AND *PHILANTHUS* (HYMENOPTERA, PHILANTHIDAE) IN MICHIGAN, WITH KEYS AND DISTRIBUTION

ROBERT R. DREISBACH

THE family Philanthidae is made up of the two subfamilies Philanthinae and Cercerinae. This family may be separated from the rest of the sphecoids by the fact that the first abdominal segment is smaller than the following segments. In Michigan the subfamily Philanthinae consists of the genera *Aphilanthops*, *Ocloclетes*, and *Philanthus*. These are beautiful little wasps, brightly maculated, which are characterized by markings on the abdomen and also by the special arrangement of the clypeus and face.

There have been but few papers published in America on this group of wasps, and many of them are very old. The references at the end of this paper list most of these.

In comparing the number of species of these genera reported for Michigan with records for other states we find nine species listed for Michigan, ten for New York, eight for Connecticut, eight for New Jersey, and seven for North Carolina.

The following key will separate the two subfamilies:

KEY FOR THE SEPARATION OF SUBFAMILIES OF THE PHILANTHIDAE

Mesopleura with a vertical furrow which separates prepectus from rest of mesopleura; this furrow originates below and just in front of posterior edge of tegula and continues to mesosternum; hind femur simple, not enlarged ..... Philanthinae

Mesopleura without such a furrow, prepectus not thus separated; hind femur enlarged and with a projection below at apex ..... Cercerinae

KEY TO THE GENERA OF MICHIGAN PHILANTHINAE

1. Inner margin of eyes not emarginate, these margins parallel throughout their length; apex of marginal cell truncate, with a small appendiculation, cubitus far beyond median ..... *Aphilanthops*

1. Inner margin of eyes emarginate, eyes at apex of head closer to each other than at any other place; cubitus originates before median 2

2. Femur hairy all over in both sexes; eyes of male above approximate; apex of marginal cell obtuse with indication of an appendiculation *Ocloctetes*

2. Femur hairy only below if at all; eyes of male farther apart at apex; apex of marginal cell acute without any trace of an appendiculation *Philanthus*

KEY TO THE GENUS *PHILANTHUS*

1. Females 2
1. Males 8

2. At least first four tergites of abdomen very coarsely punctate 3
2. Abdomen not punctate or very finely punctate. 4

3. Only first four tergites punctured, fifth impunctate, smooth, highly polished; no markings on first tergite, a broad yellow band covering anterior half of second tergite, and a very narrow yellow band on posterior edge of third, fourth, and fifth; mesonotum, scutellum, postscutellum, and lines on propodeum highly polished ... *P. gibbosus* (Fab).
3. First five tergites punctured; first tergite with a spot on each side, second with a broad anterior band covering three fourths of it and not quite continuous in center; bands on next three tergites narrow in middle and expanding on sides to about three fourths of width of tergite on sides, these bands whiter than those on first two tergites; body without smooth polished spaces of preceding species .... *P. vertilabris* (Fab.)

4. Abdomen finely, closely, aciculately punctured; tergites, except first, not constricted at base; tergites dull, not shining; third cubital cell, along radius, not longer than second cubital along radius; broad wavy band on first tergite, narrow band on next four ..... *P. solivagus* (Say)
4. Abdomen impunctate or very sparsely punctured, shining, highly polished 5

5. Abdomen very sparsely punctured; segments distinctly constricted at base; third cubital cell along radius, longer than second along radius; thorax punctured and having a rough appearance 6
5. Abdomen impunctate, highly polished; segments, except first, hardly constricted at base; thorax impunctate and highly polished; first tergite without maculations; continuous bands on third, fourth, and fifth tergites 7

6. Two whitish spots on sides of first tergite; no continuous band on third segment; second and third tergites with narrow white bands on center of posterior edge with two broad spots on sides not touching middle bands ..... *P. politus* (Say)
6. Continuous bands on all six tergites; second and third tergites with a black spot encroaching on band on posterior edge each side or edges may be almost straight, next two tergites with black spots on anterior edge of yellow band, or again black spots may be absent; clypeus with a black mark on each side ..... *P. albipilosus* (Cr.)

7. Third cubital cell along radius longer than second along radius; two lunate bands on second tergite, which do not touch in middle; bands on third and fourth tergites with straight narrow middle part abruptly narrowing toward sides, then abruptly widened to much wider band on extreme sides ..... *P. bilunatus* (Cr.)
7. Third cubital cell, along the radius, not longer than second cubital cell along radius; bands on second tergite not lunate, bands on third and fourth wider and almost straight along edge ..... *P. lepidus* (Cr.)

8. At least first four tergites of abdomen coarsely punctate 9
8. Abdomen either not punctate or else very finely punctate 10

9. Only first four tergites punctate, fifth impunctate, smooth, highly polished; face mostly black, with large yellow central spot on base of clypeus, with large yellow, elongate spot on each side of face, and one on front just behind insertion of antennae; only tip of scape and antennal segments three, four, and five with small yellow dots on lower side *P. gibbosus* (Fab.)
9. First five tergites punctate; all clypeus and front of face yellow, with large yellow transverse spot just behind antennae, which connects with the yellow on face; antennal scape and first five segments of filament entirely yellow below and rest of segments with small yellow dots below ..... *P. vertilabris* (Fab.)

10. Face covered with long shaggy hair, thorax with hair as thick as on head but not quite so long; clypeus, face, and head just short of anterior ocellus entirely yellowish white; first three tergites with broad, yellow entire band ..... *P. albipilosus* (Cr.)
10. Face and head not covered with long shaggy hair, and thorax almost bare of hair; face with black markings 11

11. Abdomen finely, closely aciculately punctured; third cubital cell along radius longer than second cubital cell along radius; broad wavy band on second tergite and narrow terminal bands on next four tergites; third tergite constricted on basal half, smooth, impunctate, shiny *P. solivagus* (Say)
11. Abdomen impunctate or very sparsely punctured, shining highly polished 12

12. Abdomen sparsely punctured, tergites distinctly constricted at base; thorax finely punctured and having a rough appearance; two white spots each side of first tergite and a short straight white narrow band at posterior edge of second and third tergites, with a broader white spot at each side; fourth and fifth with a narrow wavy continuous band ..... *P. politus* (Say)
12. Abdomen impunctate, highly polished, tergites except first hardly constricted at base; thorax impunctate and highly polished 13

13. Ocelli white, clear; ordinarily first tergite is without any maculations; second tergite has on each side two lunate bands which may meet in middle or be separate, these bands have concavity on posterior edge; third, fourth, and fifth tergites have continuous bands with straight narrow central portion which narrows on each side and then widens on the extreme edges, forming an indentation on each side on anterior edge

of band; posterior orbits opposite insertion of antennae equal to width of eye ..... *P. bilunatus* (Cr.)

13. Ocelli black, opaque; first tergite has small yellow spot black on each side; second tergite has two yellow bands which are almost straight on the posterior edge and which ordinarily do not meet in the middle; third, fourth, and fifth tergites with continuous narrow bands which are nearly straight in middle but which expand on edges to form a slightly wider band on edges; posterior orbits opposite insertion of antennae are hardly one half width of eyes ..... *P. lepidus* (Cr.)

The genera *Aphilanthops* and *Oclocletes* consist of but a single species each in Michigan, namely, *A. frigidus* (Sm.) and *O. sanbornii* (Cr.).

The distribution records are taken from insects in the museum of the University of Michigan and in the collections of Mr. Curtis Sabrosky and the author.

Of the nine species keyed six have been collected in the Upper Peninsula and all of them in the Lower Peninsula. There is no record of any species being found on Isle Royale, but one has been collected in Keweenaw County (mainland).

ANNOTATED LIST OF THE SPECIES

APHILANTHOPS FRIGIDUS (Sm.). — Dates of capture: July 16 to August 26. U. P.:[1] Baraga, Alger. L. P.:[1] Emmet, Cheboygan, Charlevoix, Lake, Oceana, Newaygo, Mecosta, Isabella, Midland, Huron, Genesee, Allegan, Ingham, Livingston, Washtenaw, Wayne.

OCLOCLETES SANBORNII (Cr.). — Dates of capture: July 9 to August 28. L. P.: Midland, Ingham, Oakland, Washtenaw.

PHILANTHUS ALBIPILOSUS (Cr.). — Dates of capture: July 20 to September 5. L. P.: Huron, Wayne. Apparently very rare.

PHILANTHUS BILUNATUS (Cr.). — Dates of capture: July 4 to September 5. U. P.: Keweenaw, Houghton, Ontonagon, Gogebic, Iron, Dickinson, Marquette, Menominee, Mackinac. L. P.: Emmet, Cheboygan, Presque Isle, Charlevoix, Leelanau, Kalkaska, Manistee, Wexford, Roscommon, Lake, Osceola, Gladwin, Newaygo, Mecosta, Isabella, Midland, Montcalm, Saginaw, Lapeer, Ingham, Oakland, Van Buren, Washtenaw, Wayne.

PHILANTHUS GIBBOSUS (Fab.). — Dates of capture: July 4 to September 20. U. P.: Marquette. L. P.: Manistee, Clare, Newaygo,

[1] U. P., Upper Peninsula; L. P., Lower Peninsula.

Isabella, Midland, Muskegon, Saginaw, Lapeer, Ingham, Livingston (George Reserve), Oakland, Kalamazoo, Washtenaw, Wayne, Berrien.

PHILANTHUS LEPIDUS (Cr.). — Dates of capture: July 30 to September 3. L. P.: Clare, Gladwin, Newaygo, Mecosta, Isabella, Midland, Wayne.

PHILANTHUS POLITUS (Say). — Dates of capture: June 25 to August 26. U. P.: Gogebic, Iron, Marquette, Chippewa. L. P.: Emmet, Cheboygan, Leelanau, Otsego, Kalkaska, Alcona, Manistee, Wexford, Roscommon, Lake, Osceola, Clare, Oceana, Newaygo, Mecosta, Isabella, Midland, Bay, Huron, Muskegon, Saginaw, Ingham, Livingston (George Reserve), Oakland, Calhoun, Washtenaw, Wayne, Berrien.

PHILANTHUS SOLIVAGUS (Say). — Dates of capture: July 21 to September 3. U. P.: Houghton, Baraga, Gogebic, Iron, Dickinson, Marquette, Mackinac. L. P.: Emmet, Cheboygan, Charlevoix, Montmorency, Kalkaska, Alcona, Midland, Huron, Oakland, Washtenaw.

PHILANTHUS VERTILABRIS (Fab.). — Dates of capture: July 3 to September 25. U. P.: Gogebic, Iron, Menominee, Delta. L. P.: Emmet, Cheboygan, Benzie, Mason, Lake, Osceola, Clare, Gladwin, Newaygo, Midland, Huron, Gratiot, Saginaw, Lapeer, Ingham, Livingston, Oakland, Kalamazoo, Washtenaw, Wayne, Berrien.

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NATURAL HYBRIDS BETWEEN TWO SPECIES OF CATOSTOMID FISHES *

CARL L. HUBBS AND LAURA C. HUBBS

HYBRIDIZATION in nature between species of *Catostomus* and between species of that genus and those of *Pantosteus* is relatively frequent throughout the western United States (Hubbs, Hubbs, and Johnson, 1943).[1] Of the nine interspecific combinations that have been discovered and described — ten if subspecies are separately enumerated — the least adequately known is *Catostomus latipinnis* × *Pantosteus delphinus*. Of this species cross there has been described only one specimen, so small (25 mm. in standard length) as to cast some doubt on the identification. Interest and satisfaction therefore attended our discovery, soon after the initial publication on catostomid hybrids, of six additional specimens of this interspecific combination, representing a new subspecies cross, *Catostomus latipinnis discobolus* × *Pantosteus delphinus delphinus*. All six specimens were included in recent collections from the Colorado River drainage in Colorado.

METHODS

In this paper we follow the statistical methods, the mode of presentation, and the criteria for the recognition of hybrids that were proposed in our 1943 report. Two procedures are added. First, we show graphically for each measured character in each comparison certain statistics for the parental species along with the actual proportions of each hybrid specimen (Figs. 1–2). The statistics for the parental forms are presented by a slight modification of the graphical

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[1] We take advantage of this opportunity to correct two annoying typographical slips in the paper by Hubbs, Hubbs, and Johnson. On page 36, line 9, for "objections" read "objects," and on page 63, line 11, for "intraspecific" read "interspecific." In the discussion of the "character index" (pp. 4–6) we inadvertently omitted reference to Van Denburgh's (1920) pioneering "summation of characters."

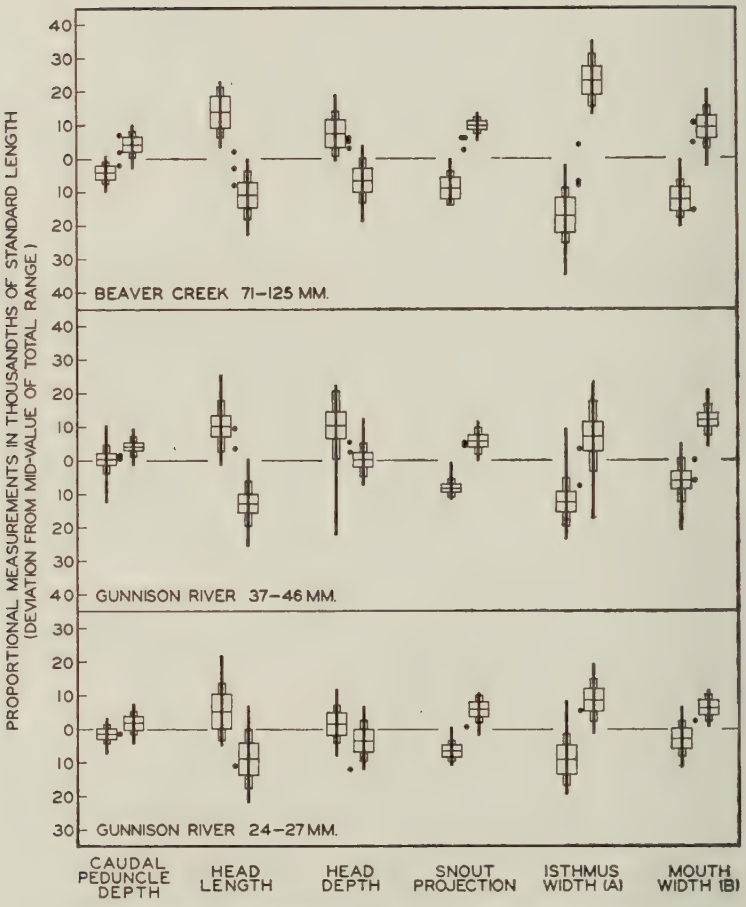

FIG. 1. Proportional measurements of the hybrids compared with those of the parental species, *Catostomus latipinnis discobolus* and *Pantosteus delphinus delphinus*, at three comparable size groups. Two collections are represented. Actual values are given for the hybrids, statistical data for the two species

method of Dice and Leraas as refined by Hubbs and Perlmutter (1942): The standard deviation on either side of the mean is represented by a hollow vertical rectangle rather than by a black bar. Secondly, we have computed, for each of the specimens of the

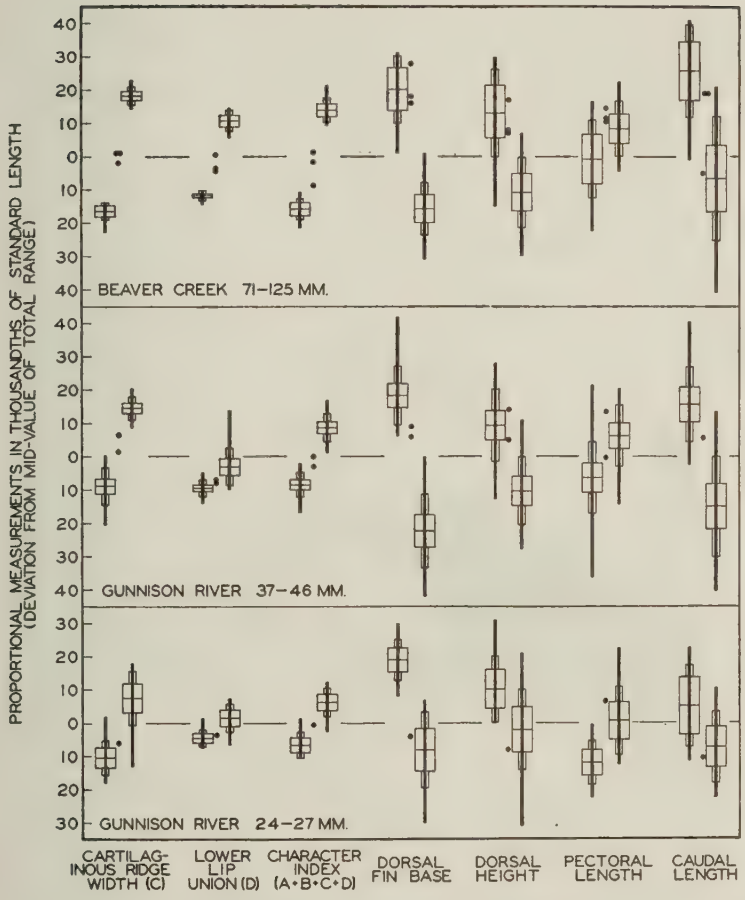

FIG. 2. Proportional measurements of the hybrids and the parental species (*continued*). For each set of the two species there are given the observed range, the mean, one standard deviation on each side of the mean (as the vertical rectangle), and twice the standard error on each side of the mean (the horizontal rectangle)

parental species in one series (that from Beaver Creek) a figure corresponding to the hybrid index. The average index shows how well each individual corresponds with its proper species and to what

degree if any the parental forms and the hybrids overlap in the simple average summation of proportional measurements (see discussion on p. 164).

In making counts and measurements we follow the methods previously specified (Hubbs, Hubbs, and Johnson, 1943 : 3–4), with the exception that we take as the origin of the dorsal fin the actual base of the first ray and measure the height of the fin (from that point to the tip of the anterior lobe), rather than the depressed length of the fin. We add one character, snout projection. This is the amount that the snout projects beyond the anteriormost point on the upper lip, expressed in thousandths of the standard length. When the lip is the more anterior the value for snout projection is negative. The measurement was made under adequate magnification with precision dial calipers. First the tip of the lip was sighted below the square edge of one caliper arm, held at an approximate right angle with the axis of the fish; then the other arm was moved closer until the tip of the snout appeared directly below its edge; the interval was estimated to 0.01 mm. This is a valuable character for the recognition of the intergeneric hybrids, for in *Pantosteus* the snout projects more than it does in *Catostomus*. Previously, however, we have not attempted a quantitative measure, because the soft bulbous snout of suckers shrinks greatly in routine preservation. The new material, fortunately, was so little shriveled that the snout projection could be measured with considerable precision. The use of borax with the formalin prevented shrinkage of the Beaver Creek specimens, which were measured before they were transferred to alcohol. The young from Gunnison River were handled in alcohol, but were soft and little shrunken, apparently as the result of crowding during the original preservation in formalin.

ACKNOWLEDGMENTS

Dr. Reeve M. Bailey coöperated in this study by supplying specimens and data from the Museum of Zoology of the University of Michigan. Dr. John T. Greenbank, a former student, collected the young hybrids from Gunnison River, along with a large quantity of other valuable material. Research Assistant Elizabeth M. Kampa helped us collect the yearling hybrids in Beaver Creek, made the fin-ray counts for the parental species from this locality, painstakingly drew the two graphs, and rendered other assistance.

MATERIAL

All material dealt with in this as in our preceding report is deposited in the Museum of Zoology of the University of Michigan (U.M.M.Z.).

Catostomus latipinnis discobolus × *Pantosteus delphinus delphinus*

U.M.M.Z., No. 142529: Three yearlings 80 to 105 mm. in standard length, collected by the authors and Elizabeth M. Kampa in Beaver Creek, a tributary of Los Pinos Creek in the San Juan River system, La Plata County, Colorado, in Township 35 North, Range 6 West, on Trinchera Ranch, along U. S. Highway 160; October 10, 1944.

U.M.M.Z., No. 142917: Three young 25 to 43 mm. long, seined by John T. Greenbank and party in a side channel then cut off from Gunnison River, at its junction with North Fork; October 20, 1943.

The material of the parental species used in the comparisons was seined with the hybrids, in numbers as indicated in the following section.

RELATIVE NUMBERS OF HYBRIDS AND OF PARENTAL KINDS

Where the yearling hybrids (U.M.M.Z., No. 142529) were collected in Beaver Creek suckers were extremely numerous, and the other fishes present, *Rhinichthys osculus yarrowi* and *Cottus bairdii punctulatus*, were common. In addition to young suckers and young dace that were discarded in the field, a total of 408 fish specimens was

TABLE I

RELATIVE NUMBERS OF *CATOSTOMUS LATIPINNIS DISCOBOLUS*, HYBRIDS, AND *PANTOSTEUS DELPHINUS DELPHINUS*

Specimens in University of Michigan Museum of Zoology	*Catostomus latipinnis discobolus*	Hybrids	*Pantosteus delphinus delphinus*
In collection containing hybrid			
U.M.M.Z., No. 142529	16 (6.3%)	3 (1.2%)	236 (92.5%)
U.M.M.Z., No. 142917	258 (23.4%)	3 (0.3%)	841 (76.3%)
Total	274 (20.2%)	6 (0.5%)	1,077 (79.4%)
From the Colorado River system	1,733 (33.8%) [1]	6 (0.1%)	3,381 (66.0%) [1]

[1] There may be a slight error in these numbers and percentages (see pp. 152, 160–162).

seined during one-half hour in a few seine hauls. The thick concentration of fish was attributable to the almost complete stair-stepping of the very small creek by innumerable beaver dams (according to Feast, 1944 : 1, ninety-five beaver were trapped during the winter of 1943–44 within the Trinchera Ranch, on which Beaver Creek is the water supply). Like the hundreds of other ponds, the one that was fished provided excellent room and shelter for the fish, for the water was several feet deep in the lower part of the pond and as much as twenty-five feet wide, and there was much brush in and over the water; the short stretch of gravelly current between the pond and the next dam upstream obviously afforded suitable spawning grounds.

It may be presumed, however, that the spawning fish must have been much crowded on the limited area of gravel. This is one of the circumstances that have appeared to be conducive to hybridization, for instance, in the Centrarchidae (Hubbs and Hubbs, 1932 : 428).

In the one beaver pond and short stretch of running water that was seined the two species of sucker were present in very unequal numbers (Table I). Along with the 3 yearling hybrids there were preserved 5 young and 11 half-grown of *Catostomus latipinnis discobolus* and 213 young and 23 half-grown to adult specimens of *Pantosteus delphinus delphinus*. Had the myriads of young suckers been saved, the recorded proportion of *Pantosteus* would obviously have been much higher. It is very probable that the conditions were relatively unfavorable for the *Catostomus*, which is ordinarily a fish of larger and swifter waters. Since so few of the young suckers were of this species it is probable that the local conditions were not very favorable for spawning. For the *Pantosteus*, in contrast, the situation seems to have approached the optimum. The occurrence of only a few of the *Catostomus* with such large numbers of the *Pantosteus* yielded two very different hybrid ratios; in the sample, relatively random except for the discarding of many young that were predominantly *Pantosteus*, the hybrids were 19 per cent as numerous as the *Catostomus* but only 1.3 per cent as many as the *Pantosteus*. It is unfortunate that the hybrids were not recognized in the hurried field collecting, because it would have been easy to collect a very large and more completely random sample for a more adequate analysis of the relative frequency of the hybrids, and also for a more thorough statistical comparison of their characters with those of the parental forms.

In Gunnison River also *Pantosteus delphinus delphinus* predominated, but the disparity in numbers of the parental species was not so great as in Beaver Creek (Table I). With the 3 young hybrids there were seined 256 young and 2 yearlings of *Catostomus latipinnis discobolus* and 841 young (1 possibly a yearling) of the other species. Associated fishes occurred in the same collection in the following numbers: *Catostomus commersonnii sucklii*, 27 young; hybrids, *C. c. sucklii* × *Pantosteus d. delphinus*, 9 young; *Rhinichthys osculus yarrowi*, 19 young and yearlings; *Gila robusta robusta*, 14 young. The abundance of young fish at this locality suggests that there may have been some crowding of the adults on the spawning grounds, here as well as in Beaver Creek.

In all probability *Catostomus latipinnis discobolus* and *Pantosteus delphinus delphinus* hybridize less frequently than do certain other pairs of species in these genera (compare Table I of this paper with Table XXXI in Hubbs, Hubbs, and Johnson, 1943 : 64). Many of the collections in the Museum of Zoology contain both species without any crosses. The occurrence of three hybrids in the Beaver Creek series may be attributed to the association of a few individuals of the *Catostomus* with an abundance of the *Pantosteus*, and the factor of differential abundance may also have contributed to miscegenation in the Gunnison, though the disparity in numbers was apparently much less in that stream. That the cohabitation of a rare and an abundant species is conducive to natural hybridization is suggested by some of the data given for suckers by Hubbs, Hubbs, and Johnson and is more definitely indicated by the known information on hybridization in nature between species of Cyprinodontidae (Hubbs, Walker, and Johnson, 1943). Other data confirm the hypothesis.

The evidence (p. 152) that *Pantosteus delphinus delphinus* in Gunnison River had crossed more commonly with the introduced *Catostomus commersonnii sucklii* than with the native *C. latipinnis discobolus* falls in line with the theory that hybridization rates may be increased when exotic and indigenous species meet. Since the conclusions by Hubbs, Hubbs, and Johnson (1943 : 12–14, 39, 63) were published, strong additional evidence has been accumulated to indicate that *C. c. sucklii* after its introduction and rapid spread in the Colorado River system has hybridized with the native suckers in very high frequency. If plans mature, this evidence will be presented by Hubbs and Miller, along with data which suggest that the introduction

of an exotic species is a main cause of the very high frequency of hybridization between *Catostomus* species and *Pantosteus santa-anae* (Hubbs, Hubbs, and Johnson, 1943 : 47 48, 63) and between *Gila orcuttii* and *Siphateles mohavensis* (Hubbs and Miller, 1943). That the natural derangements caused by the introduction of an exotic are often responsible for a partial breakdown of species lines is a conclusion repeatedly stressed by Huxley (1943).

EVIDENCE FOR HYBRIDIZATION

The interpretation of six specimens as natural hybrids between *Catostomus latipinnis discobolus* and *Pantosteus delphinus delphinus* is based on such criteria as those outlined by Hubbs, Hubbs, and Johnson (1943 : 11–14). Again we have only circumstantial evidence, but to us it seems quite satisfactory.

Both sets of three hybrids were collected with the putative parents. In Beaver Creek no other species of sucker was present, nor was any other expected. In Gunnison River a third species, *Catostomus commersonnii sucklii*, did occur, but the *C. l. discobolus* × *P. d. delphinus* hybrids exhibited none of the particularly diagnostic characters of *C. c. sucklii*, and they were obviously different in the expected features from the hybrids between *C. c. sucklii* and *Pantosteus d. delphinus*.

The conclusions that the breeding seasons of *C. l. discobolus* and *P. d. delphinus* coincide or broadly overlap and that the hybrids stem from spawning at about the time when the parental forms breed are verified by the size of the young in the Gunnison River collection of October 20. The 256 young of the year of *C. l. discobolus* ranged in standard length from 21 to 15 mm. (the two specimens, 77 and 78 mm. long, were interpreted as yearlings). The 841 young of the *Pantosteus* ranged in length from 20 to 53.5 mm. (the 53.5 mm. fish, nearly 10 mm. longer than the next largest, may well have been a yearling). The three hybrids were of similar size: 25, 40, and 43 mm.

The characters of the hybrids are not those of any known or expected species of sucker, but appear to be normal. In several respects they fail to fit either the generic or the specific system. The distinctions that separate *Catostomus* and *Pantosteus* consistently throughout the Colorado River and other stream systems of the Pacific drainage break down in these supposed hybrids.

Like most interspecific hybrids in the fish group, the six specimens

at hand exhibit a highly distinctive intermediacy between the particular parental forms that are presumed to have miscegenated. As is indicated in the following section, the intermediacy of the hybrids runs through the whole gamut of characters. On the average the fin rays are intermediate in number. Differences in scale numbers were not determined, for the counts are not greatly different in the parental forms, but the hybrids appear to fall between the two species in the differential size of the scales fore and aft. Interjacency is also shown in the very distinctive lip and mouth structures and in the degree of intestinal coiling. Most proportional measurements of the hybrids lie between those of the parental species. In the young, which are less strikingly different than the adults in lip structure and proportions and in which the determination of these characters is more difficult and more subject to error, another set of differences, those of the melanophore pigmentation, comes into use. The pigmentary characters were studied in every one of the several hundred young suckers in the collections containing the hybrids here treated. In these respects, too, the hybrids are nicely intermediate.

INTERMEDIACY OF THE HYBRIDS

The yearling hybrids from Beaver Creek were readily recognized as such on sorting the collection in the laboratory and would have been identified in the field had the collecting been less hurried, because they differed markedly from each parental species yet strongly resembled both. Their intermediacy is very striking. This is particularly true of the trenchant generic characters of mouth structure (Hubbs, Hubbs, and Johnson, 1943 : 33 36). The upper lip overhangs more than in the *Catostomus*, less than in the *Pantosteus*, and is intermediate in papillation. Between the lips at each side of the oral disk there is an emargination, where there is a deeper incision in the *Pantosteus* but none in the other parental species. The lower lips are more broadly united on the midline than in the *Catostomus*, but are less connected than in the *Pantosteus*. The cartilaginous ridge of the lower jaw is broader, more truncate, and more sharply shouldered on the side than it is in the *Catostomus*, but is less modified than in the other form. On the average the mouth is broader than in the former species but narrower than in the *Pantosteus*. The snout is more bulbous and protruding than in *C. l. discobolus*, but less so than is usual in *P. d. delphinus*.

TABLE II

PROPORTIONAL MEASUREMENTS OF *CATOSTOMUS LATIPINNIS DISCOBOLUS*, HYBRIDS, AND *PANTOSTEUS DELPHINUS DELPHINUS*

The measurements are expressed as thousandths of the standard length. There are given for each item the range of the proportions (for the hybrids the actual figures) and below this the mean and, for each parental species, the standard error. For the size groups (first sets of rows) the standard error is not computed, but the number of specimens (in parenthesis) follows the mean.

	Beaver Creek	Gunnison River	
Size group, mm.			
C. l. discobolus	78–125	39–46	24–27
	100 (10)	41 (24)	26 (12)
Hybrids	80, 104, 105	40, 43	25 (1)
	96 (3)	42 (2)	
P. d. delphinus	71–124	37–44	24–26
	90 (14)	39 (22)	24 (13)
Caudal peduncle depth			
C. l. discobolus	65–76	56–79	60–71
	70.8 ± 1.0	69.0 ± 0.9	66.1 ± 0.8
Hybrids	73, 77, 82	69, 70	66
	77.3	69.5	
P. d. delphinus	72–85	67–78	63–75
	79.2 ± 1.1	72.7 ± 0.6	69.4 ± 1.0
Head length			
C. l. discobolus	260–280	262–289	270–297
	270.8 ± 2.4	273.8 ± 1.6	280.3 ± 2.6
Hybrids	249, 254, 259	267, 273	264
	254.0	270.0	
P. d. delphinus	234–257	238–264	253–282
	246.0 ± 1.9	250.7 ± 1.4	266.2 ± 2.4
Head depth			
C. l. discobolus	163–183	139–184	166–186
	171.3 ± 2.1	172.1 ± 2.0	175.6 ± 1.7
Hybrids	167, 169, 170	164, 167	162
	168.7	165.5	
P. d. delphinus	145–168	154–174	162–181
	157.3 ± 1.8	161.7 ± 1.1	170.6 ± 1.7
Snout projection			
C. l. discobolus	− 8.0– + 5.5	2.5–13.8	2.2–13.8
	− 3.4 ± 1.6	6.1 ± 0.6	6.7 ± 0.9
Hybrids	8.2, 11.6, 11.6	18.7, 19.7	13.8
	10.5	19.2	
P. d. delphinus	10.6–19.2	14.1–26.1	11.1–24.0
	15.3 ± 0.7	20.1 ± 0.9	19.1 ± 1.1

TABLE II (*continued*)

	Beaver Creek	Gunnison River	
Isthmus width (A)			
C. l. discobolus	44–77	55–88	46–74
	61.9 ± 2.6	66.1 ± 1.5	56.5 ± 2.2
Hybrids	71, 72, 83	71, 82	71
	75.3	76.5	
P. d. delphinus	92–114	61–102	64–85
	102.1 ± 2.1	85.6 ± 2.2	74.2 ± 1.7
Mouth width (B)			
C. l. discobolus	90–110	65–91	65–83
	98.3 ± 1.8	80.0 ± 1.3	73.7 ± 1.5
Hybrids	95, 115, 121	80, 86	79
	110.3	83.0	
P. d. delphinus	108–131	90–107	77–88
	119.7 ± 1.7	98.0 ± 1.0	82.9 ± 1.1
Cartilaginous ridge width (C)			
C. l. discobolus	29–38	24–45	25–45
	35.5 ± 0.8	35.6 ± 1.1	32.6 ± 1.5
Hybrids	50, 53, 53	46, 51	37
	52.0	48.5	
P. d. delphinus	66–75	53–65	30–61
	70.1 ± 0.7	59.0 ± 0.8	50.5 ± 2.2
Lower lip union (D)			
C. l. discobolus	13–17	12–21	10–19
	15.6 ± 0.3	16.5 ± 0.5	13.0 ± 0.7
Hybrids	23, 24, 28	18, 19	14
	25.0	18.5	
P. d. delphinus	33–42	16–40	11–25
	38.1 ± 0.9	23.9 ± 1.2	19.0 ± 1.2
Character index (A + B + C + D)			
C. l. discobolus	190–233	164–225	154–208
	211.3 ± 4.0	198.2 ± 3.1	175.8 ± 4.5
Hybrids	240, 267, 281	221, 231	201
	262.7	226.0	
P. d. delphinus	312–360	235–301	192–250
	330.0 ± 3.8	266.4 ± 3.6	226.7 ± 4.8
Dorsal fin base			
C. l. discobolus	161–190	166–202	154–176
	179.1 ± 3.2	178.3 ± 1.8	164.9 ± 1.8
Hybrids	175, 177, 187	166, 169	142
	179.7	167.5	
P. d. delphinus	128–160	118–160	116–153
	143.2 ± 2.1	137.6 ± 2.4	137.9 ± 3.2

TABLE II (*concluded*)

	Beaver Creek	Gunnison River	
Dorsal height			
C. l. discobolus	203–248	208–249	216–247
	230.9 ± 4.2	230.3 ± 2.2	226.2 ± 2.9
Hybrids	225, 226, 235	226, 235	208
	228.7	230.5	
P. d. delphinus	188–225	193–232	185–237
	207.1 ± 2.8	210.6 ± 2.2	214.0 ± 3.4
Pectoral length			
C. l. discobolus	172–211	178–221	170–192
	193.7 ± 3.7	193.1 ± 2.2	178.5 ± 1.9
Hybrids	205, 206, 209	199, 213	199
	206.7	206.0	
P. d. delphinus	191–217	190–220	180–215
	202.8 ± 2.2	205.7 ± 1.9	193.1 ± 2.8
Caudal length			
C. l. discobolus	256–298	274–317	264–298
	282.6 ± 4.4	292.1 ± 2.6	280.5 ± 4.3
Hybrids	252, 276, 276	282 (1)	265
	268.0		
P. d. delphinus	216–278	236–290	253–286
	250.4 ± 5.0	261.4 ± 3.4	268.1 ± 3.0

The intermediacy of the three yearling hybrids is further indicated by an analysis of the proportional measurements, which were taken of the parts that differ in relative size in the parental species (Table II and upper frames of Figs. 1–2). On the average the caudal peduncle is deeper than in the *Catostomus*, slenderer than in the *Pantosteus*, and the head is shorter and slenderer than in the former species, but is longer and deeper than in the latter. The snout projection is consistently greater than in the *Catostomus* specimens measured but is less than in most of the *Pantosteus* examples. The isthmus is wider than usual in the *Catostomus*, consistently narrower than in the other species. The mouth width averages intermediate; the cartilaginous ridge width is consistently interjacent, as is also the length of the union of the lower lips. Uniform intermediacy is also shown by the character index that summates the mouth and isthmus measurements.

The fins as a rule are unexpectedly large. A similar situation has

been noted and attributed to hybrid vigor in certain other hybrids, for example, in *Gila orcuttii* × *Siphateles mohavensis* (Hubbs and Miller, 1943 : 367, 370–374).

In identifying the young hybrids less reliance could be placed on the characters, outlined above, that proved useful in recognizing the yearling hybrids and in indicating them as intermediate between the parental species. In the specimens about 40 mm. long the distinctions used in the half-grown hybrids are still rather readily apparent, but in the young approximately 25 mm. long these differences are too small and too overlapping (Table II and lowest frames of Figs. 1–2) to make possible either a fully trustworthy identification of the hybrids or a completely satisfactory test of their intermediacy. Certain of the characters, however, are reasonably reliable. Thus one can see that the mouth is protractile almost straight downward in the *Catostomus*, but downward and backward in the *Pantosteus*. Furthermore, the greater size disparity of the scales on the anterior and on the posterior parts of the body in the *Pantosteus* is early apparent. In these important respects the young hybrids are intermediate.

As the characters that distinguish the half-grown and adult hybrids from both parental species become decreasingly serviceable in fish grading downward in standard length from about 40 to 25 mm., certain pigmentary differences that gradually fade out at lengths much greater than 40 mm. become very useful in the identification of the hybrids and in the testing of the theory that the characters of the hybrids are intermediate between those of the parental species. The three young hybrids show a weak to moderate development of each of the pigmentary characters, whether the development or specialization of the melanophores in a certain area or manner be diagnostic of the *Catostomus* or of the *Pantosteus*. Thus in all these respects the hybrids again are intermediate.

The more striking of the observed pigmentary differences between the 25– to 40–mm. young of *Catostomus latipinnis discobolus* and *Pantosteus delphinus delphinus* are as follows:

Pigment on side of muzzle. — In *C. l. discobolus* the dark blotch on the side of the snout is abruptly down-curved, because most of the melanophores that lie on the posterior part of the maxillary (showing through the preorbital) are ventral to the superficial dark band that extends horizontally along the side of the head. In *P. d. delphinus* the pigmented area is not abruptly curved, except when the mouth is pulled open, for when the jaws are in normal position the melanophores on the posterior part of the maxillary are covered by the dark band.

Melanophores on ridge underlying nostril. — These color cells are usually small in the *Catostomus*, whereas in the *Pantosteus* they are usually rather markedly enlarged.

Black peritoneum as seen through the translucent body wall. — In *C. l. discobolus* the black area is less conspicuous than it is in *P. d. delphinus*, because it is more hidden by silvery (guanine) pigment and because it extends up not more than half instead of distinctly more than half the side of the trunk.

Intestinal canal as seen by the impressions visible through the thin belly wall. — The coils are more loosely, less extensively, and less transversely coiled in the *Catostomus* than in the other species.

Pigment on back before dorsal fin. — In *C. l. discobolus* isolated giant melanophores are more conspicuous than the crosswise mottlings and reticulations, which are composed of much smaller melanophores. In *P. d. delphinus* the reverse is true. Along the median predorsal line the large melanophores typically form a definite single file in the *Catostomus*, but in the *Pantosteus* are usually too few and too scattered to form such a file.

Superficial melanophores along middle one third of body. — In *C. l. discobolus* these cells are relatively small and sparse and over the caudal base are scarcely developed, whereas in the other parental species they are larger and thicker and are commonly developed in the skin over the caudal base. In some of the *Pantosteus* specimens the superficial melanophores (not to be confused with the deep-lying pigment) are somewhat enlarged and concentrated in the hypural region, but never form a definite basicaudal spot as they do in *Catostomus commersonnii sucklii* and, less boldly, in the young *C. c. sucklii* × *P. d. delphinus* hybrids.

Deep-lying pigment in the myocommata, forming V*'s with points on the axial septum.* — These marks are usually more prominent in *C. l. discobolus* than they are in the *Pantosteus*.

Black streak in axial septum on caudal region of body. — In the young of the *Catostomus*, this streak is usually continuous or subcontinuous, rarely disrupted into dashes, and very seldom obsolescent in fish shorter than 40 mm. In the *Pantosteus* the mark is lacking or is represented by slight wisps of pigment.

Deep-lying pigment at base of lower procurrent caudal rays. — Most young of *C. l. discobolus* are conspicuously pigmented about these rudimentary rays, whereas in nearly all young of *P. d. delphinus* the pigment here is faint or lacking.

Deep-lying pigment on hypural plate as seen by transmitted light. — In the *Catostomus* the hypural pigment typically forms two to four dark streaks, extending upward and backward, sufficiently separated so as not to give the appearance of a solidly filled semicircle. In the other parental species the oblique streaks are broader and more diffuse and are conjoined around the posterior edge of the hypural. As a result, the hypural pigment in this species gives the impression of a solidly dark semicircle.

It is highly probable that pigmentary differences, as is often true, will be found to distinguish the species at even earlier stages. Adequate material to test this probability, however, is not at hand. There is available one series (U.M.M.Z., No. 92248) of 570 specimens, grading from postlarvae 11 mm. in standard length to early juveniles

22 mm. long, but the entire set seems to represent *C. l. discobolus* (and is so recorded in Table I). This collection was made in Green River near Green River, Wyoming, by Leonard P. Schultz and Allan C. DeLacy on June 23, 1931. The largest specimens (22 mm.) and some nearly as large (18 to 21 mm.) agree with the preceding characterization of the young of this form of *Catostomus*. Most of those 16 to 21 mm. long differ in some respects. They show the strong axial streak of this sucker. A middorsal row of large melanophores extends from the head to a wedge of smaller specks just before the dorsal fin. There is a dorsal dark band of moderate width, in which the melanophores in an irregular to even file, toward the outer edge of either side, extending from near the head to the side of the dorsal fin, approach those of the median predorsal line in size. A black streak marks the base of the procurrent caudal rays, above and below. A fine line extends along and before each side of the anal base and another, doubled in some, continues along the lower edge of the caudal peduncle. A few dots usually occur on the middle of the breast and a few may accompany the preanal fin fold. There is a dark streak, often hidden, on the pleural peritoneum. Three blackened areas, decreasing in the area forward, are seen on the top of the head. The upper part of the opercle bears black specks, as does the muzzle down to the upper lip. A black streak marks a portion of the lower posterior edge of the orbit. Otherwise the 16- to 21-mm. young are almost wholly devoid of pigment. In the series grading from 16-mm. young to 11-mm. postlarvae several changes (the reverse of the development sequence) are observed: the axial streak becomes dotted and undeveloped forward; the predorsal line becomes more of a streak and is usually less extended toward the dorsal fin; the smaller flecks of the dorsal band are not developed; as a result a double file of dots stands out, from near the head to the dusky wedge in front of the caudal fin; the three blotches on the top of the head become more discrete and the melanophores of the successive blotches become smaller forward; the specks on the opercle and muzzle, the streak on the lower border of the orbit and the peritoneal pigment are little or not at all developed. The entire lot seems to comprise a graded series of the single form, but there is no final proof that the *Pantosteus delphinus* pigment pattern does not grade into the same expression. If the two species should prove alike in the postlarval and very early juvenile stage, the relative numbers of the parental

species recorded in Table I would be in error, overweighed on the *Catostomus* side. The error would not be large, however, for most of the specimens in this big series (certainly all of the larger ones) are definitely referable to *C. l. discobolus.*

In their proportional measurements the young hybrids show more overlap on the parental species than do the yearlings (Table II and Figs. 1–2). This is due not only to the fact that the differences between the parents are actually less wide and less sharp, but also to the circumstance that the measurements cannot be made with precision on the very small fish, even though they be taken very carefully under a binocular microscope with precision dial calipers. Furthermore, the young appear to be more variable, as though their characters were less definitely fixed along the patterns of the respective species. Despite these circumstances, the measurements of the young, particularly the more critical mouth and isthmus proportions, appear to be essentially intermediate. The 25-mm. specimen is especially variable in its characters; for instance, the head is smaller than usual in *Pantosteus.* Were it not for the confirmation of the pigmentary characters it would have been hazardous to identify this specimen as a hybrid.

Both lots of hybrids, yearlings as well as young, exhibit an intermediacy in fin-ray counts (Table III) that confirms the interpretation of them as the products of interspecific crossing. The dorsal and the pelvic counts of the hybrids overlap the counts for both parental species, but this would be expected, since the counts for the species are not invariably different. The overlap between the counts for the parental kinds is eliminated for the Beaver Creek series and is almost circumvented for the Gunnison River series by the use of a simple character index, namely, the sum of the counts for the dorsal and for both pelvic fins. In this summary index the intermediacy of the hybrids is particularly well demonstrated for the young from Gunnison River, but is not so well indicated for the Beaver Creek yearlings. However, the identification of the larger fish as hybrids is especially free from doubt.

Hybrid indices (Table IV) confirm and specify the intermediacy of the hybrids. The grand-average index for the counts is 35, indicating a closer agreement with the *Catostomus* than with the *Pantosteus.* For the critical measurements of the mouth and isthmus the average index of 43 shows a closer approach toward exact intermedi-

TABLE III

FIN RAY COUNTS OF *CATOSTOMUS LATIPINNIS DISCOBOLUS*, HYBRIDS, AND *PANTOSTEUS DELPHINUS DELPHINUS*

	Beaver Creek			Gunnison River		
	Catosto-mus	Hybrids	*Pantos-teus*	*Catosto-mus*	Hybrids	*Pantos-teus*
Dorsal rays						
10	.....	.....	20	.....	.....	22
11	3	1	3	3	2	27
12	12	2	.....	23	.....	1
13	1	.....	.....	23	1	.....
14	.....	.....	.....	1	.....	.....
N	16	3	23	50	3	50
M	11.87	11.67	10.13	12.44	11.67	10.58
SD	0.50	.....	0.34	0.64	.....	0.53
SE	0.13	.....	0.07	0.09	.....	0.07
Pelvic rays *						
8	.....	.....	3	.....	.....	1
9	.....	1	43	.....	1	83
10	26	5	.....	67	5	16
11	6	.....	.....	33	.....	.....
N	32	6	46	100	6	100
M	10.19	9.83	8.93	10.33	9.83	9.15
SD	0.40	.....	0.25	0.47	.....	0.38
SE	0.08	.....	0.05	0.06	.....	0.04
Total dorsal and pelvic rays						
26	.....	.....	1	.....	.....	.....
27	.....	.....	1	.....	.....	.....
28	.....	.....	18	.....	.....	20
29	.....	.....	3	.....	.....	19
30	.....	.....	.....	.....	1	8
31	3	2	.....	1	1	3
32	9	1	.....	17	.....	.....
33	2	.....	.....	16	1	.....
34	2	.....	.....	8	.....	.....
35	.....	.....	.....	8	.....	.....
N	16	3	23	50	3	50
M	32.19	31.33	28.00	33.10	31.33	28.88
SD	0.91	.....	0.60	1.10	.....	0.89
SE	0.23	.....	0.13	0.16	.....	0.12

* The pelvic rays were counted on both sides; hence the number of cases is twice the number of specimens. In computing the standard error of the mean, allowance was made for correlation between the rays in the left and right fins, according to a method to be proposed later (Hubbs and Hubbs, MS).

acy. A still closer approach to the exactly intermediate index of 50 is exhibited by the average of 52 for all proportional measurements. The grand average for all counts and all measurements, with each determination given equal weight, happens to fall at 50. In the total ensemble of their characters, therefore, the six hybrids may be said to fall just halfway between the parental species. In the separate characters, however, there is considerable deviation from the perfect index of 50. The value for the fin rays is low, as already indicated. For size, however, the index for the dorsal fin is seen to approach that of the *Catostomus*, whereas the value for the pectoral fin exceeds that for the *Pantosteus;* in each case the reason is the large size of the fins in the hybrids.

The average index for all characters as calculated for each individual ranges from 33 to 78 for all six specimens and deviates more than 11 per cent from 50 in only two individuals. For all characters, counts also included, the average indices for the individuals range from 28 to 81 (from 34 to 51 in 4 specimens). The most extreme values are for young specimens, which furnish rather unreliable measurements.

For the yearling specimens, for which fluctuations in the hybrid index are caused by normal variations more than by errors in measurement, the average individual hybrid indices for all measurements may be compared with corresponding figures for the parental species:

Catostomus l. discobolus (10): −31 to 10.5;
Hybrids: 39, 53, and 61;
Pantosteus d. delphinus (14): 74 to 125.

SUMMARY

Hybridization in nature between species of catostomid fishes is confirmed by an analysis of six specimens recently collected in Colorado. They represent a species combination, *Catostomus latipinnis* × *Pantosteus delphinus*, that was previously known from a single very young specimen, and they establish a new subspecies cross, *C. l. discobolus* × *P. d. delphinus*. These forms appear to hybridize less frequently than do some other pairs of species in the family. The association of a rare and an abundant species and the crowding of fish on limited spawning grounds appear to explain for one locality why the hybrids at hand were produced, and similar factors may have operated at the other place. A higher rate of

TABLE IV

HYBRID INDICES FOR ALL CHARACTERS STUDIED IN *CATOSTOMUS LATIPINNIS DISCOBOLUS*, HYBRIDS, AND *PANTOSTEUS DELPHINUS DELPHINUS*

An index of 50 indicates exact intermediacy, on a percentage scale in which the average for the *Catostomus* is set at, 0 that for the *Pantosteus* at 100. One unreliable index, for a character in which the parental forms differ by less than 4 per cent, is enclosed in parentheses and is disregarded in computing the averages for individual hybrids and for characters. The two summary character indices are also eliminated in computing the averages.

	Beaver Creek specimens				Gunnison River specimens				Grand Average
	80 mm.	104 mm.	105 mm.	Average, 80–105 mm.	40 mm.	43 mm.	Average, 40–43 mm.	25 mm.	
Dorsal rays (A)	− 7	50	− 7	12	− 30	77	23	77	27
Rays, both pelvics (B)	15	15	55	28	28	28	28	113	42
Index (A + B)	5	26	26	19	2	50	26	97	34
Average, ray counts	4	32.5	24	20	− 1	53	26	95	35
Caudal peduncle depth	74	26	133	78	0	27	13	− 3	43
Head length	48	68	88	68	3	29	16	116	59
Head depth	31	9	16	19	49	78	63	(272)	37
Snout projection	80	80	61	74	90	97	93	57	77
Isthmus width (C)	25	23	52	33	26	82	54	82	48
Mouth width (D)	− 15	78	106	56	0	33	17	58	43
Cartilaginous ridge width (E)	42	51	51	48	66	44	55	25	47
Lower lip union (F)	33	55	37	42	34	20	27	17	33
Index (C + D + E + F)	24	47	59	43	33	48	41	50	43
Dorsal fin base	6	11	− 22	− 1	23	30	27	85	22
Dorsal height	− 17	21	25	10	21	− 23	− 1	149	29
Pectoral length	135	124	168	142	46	157	101	146	129
Caudal length	20	95	20	45	.....	32	32	125	58
Average, measurements	39	53	61	51	33	51	42	78	52
Grand average	34	50	50	46	28	51	40	81	50

crossing results when an exotic species becomes associated with a native form.

A variety of circumstantial but seemingly reliable evidence supports the interpretation of these specimens as interspecific hybrids.

The hybrids are intermediate between the parental species in almost all their characters. This is perhaps most strikingly true of the trenchant generic differences in mouth structures, but applies also to the projection of the snout, the width of the isthmus, and various other head and body proportions. The fins, however, are unexpectedly large. The characters that show intermediacy in the larger fish become less serviceable in the smaller young, though such characters as the direction of protractility of the mouth and the disparity in the size of the scales anteriorly and posteriorly are early apparent, and are intermediate in the hybrids. A study of numerous pigmentary differences, most of which disappear with age, verifies the identification of the young and the determination of their characters as intermediate.

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FOOD AND HABITS OF THE COMMON WATERSNAKE, *NATRIX S. SIPEDON*, IN MICHIGAN*

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INTRODUCTION

THE purposes of this study are to investigate the food habits of the common watersnake (*Natrix s. sipedon*) in Michigan and to determine, so far as possible on the basis of these and other data, its effect on game-fish production both at rearing stations and on natural waters. Answers to certain questions raised by Netting (1941) in regard to its biology and economics are given here for a single region. This article is one of a series in which we are making both joint and individual reports on the natural enemies of fish in Michigan.

We acknowledge with gratitude the assistance of our colleagues and coworkers in the Michigan Department of Conservation who contributed many specimens and aided us in the field. Particular thanks are due to Dr. A. S. Hazzard, director of the Institute for Fisheries Research, and to Dr. Carl L. Hubbs for their many and varied helps.

Our materials are principally from the Lower Peninsula of Michigan, from both natural waters and rearing establishments. We examined a total of 302 specimens. Of these, 114 were empty, so that the data in this paper are based on analyses of the stomach contents of 188 snakes.

* Contribution from the Department of Zoology of the University of Michigan and the Institute for Fisheries Research of the Michigan Department of Conservation. Financial aid was given this study by the Associated Fishing Tackle Manufacturers.

Of the 200 specimens that we sexed 96 (48 per cent) were females and 104 (52 per cent) were males. The lengths of 287 specimens of both sexes that were measured averaged 24.4 inches and ranged from 8.4 to 38.2 inches. These individuals were collected from May to the end of September, mostly during July and August.

HABITS AND ECOLOGY

Relations to the Aquatic Environment and Populations

Though watersnakes are naturally aquatic, in Michigan they are not present wherever there is water, nor are population densities uniform even in closely similar situations. We have failed to find any in certain springs that were inhabited by fish and frogs. They are characteristically lacking or very sparse in cold creeks or in portions where the water is extremely well shaded, as it is in swamps where alders or cedars grow beside and over it. Around large bodies of water, either lakes or rivers, they occur mostly in marginal situations. They are apparently absent from long stretches of barren sandy shores, such as those of Lake Michigan near Grand Haven and Lake Superior west of Grand Marais. Both Brown (1940) and we have experienced good collecting along drift-strewn Great Lakes' shores, including those of islands. We have taken specimens from lakes, ponds, and marshes of many sizes and kinds and in streams ranging from mere trickles to rivers. We found the watersnake most abundant in medium-sized streams, tributary to Lake Michigan, in the western part of the Lower Peninsula.

It is our impression that watersnake populations generally increase in shallowly impounded parts of streams. Waters held by beaver dams appear to be an exception, since in Michigan this snake rarely frequents them. In studies of more than a hundred such ponds Salyer has seen watersnakes in only five or six. The impediment to feeding offered by the soft bottom deposits of such sites may be the factor accountable. Soupy peat makes the water very cloudy when it is disturbed. In Michigan the watersnake is essentially an animal of clear waters.

Numerical estimates of watersnake populations are few and, since they are based on snakes seen or collected, are always too low. On the Platte River we once saw 93 specimens within about three miles from Honor down to Platte Lake. From a single small dam of stones

on the same stream near Bendon ten individuals were taken. During three coverages of a two-mile portion of Bear Creek (Manistee County) and intensive collecting (once by boat and twice by wading; all collections made about midday) a total of 58 watersnakes were seen, and of these 32 were captured (Table I).

TABLE I

Results of Three Collecting Trips over Two Miles of Bear Creek

Date 1944	Number captured	Number seen but not captured	Total number of specimens seen
July 9	7	8	15
August 8	13	8	21
August 22	12	10	22

From these data it is evident that: (1) a very large number of watersnakes inhabit this section of Bear Creek; (2) population estimates based on snakes seen are inaccurate and probably too low; (3) collecting can be more effectively carried on by wading than from a boat.

It is not uncommon for watersnakes to leave the water. Bearing of young, basking in the sun, resting in the shade, and hibernation take place on land. Here cover is sought under rocks, logs, or débris; for sunning the exposed surfaces of these objects as well as the branches of trees are used. We have taken specimens from streamside bushes up to six feet above the water, and Brown (1940) has found them at a height of eight feet. A few were collected in woodlands several hundred yards from lake shores.

Periods of Activity

The season of greatest activity coincides with the months during which collections were made — May through September but principally June through August. Watersnakes are torpid at temperatures less than 50° F. (Brown, 1940), and so movements are limited to the warmer months but apparently are reduced in hot weather, particularly during the heat of day. If predation by this reptile lessens fish production, then, one need not be concerned about it during late fall, winter, and early spring months in Michigan.

Feeding Habits

It is generally known that watersnakes feed at night as well as during the day. For example, the diamondback watersnake (*Natrix r. rhombifera*) and the green watersnake (*Natrix c. cyclopion*) seek food at night (Trapido, 1943). We made only a few observations after dark, but we have seen common watersnakes fishing on riffles relatively undisturbed by our artificial lights. The high incidence of muddlers (*Cottus spp.*) in the food of trout-stream watersnakes (Table III) shows both bottom and nocturnal feeding, since these fish are characteristic bottom dwellers and are secretive in the daytime. Additional evidence of nighttime feeding is the fact that specimens collected at midday and during the late hours of warm days usually contain little if any food. Individuals taken before noon, on the other hand, ordinarily have food in their stomachs.

The occurrence in the food of watersnakes of muddlers, western blacknose dace (*Rhinichthys atratulus meleagris*), and longnose dace (*Rhinichthys c. cataractae*) confirms observations that feeding may take place on the riffles of streams or in fast water. In fact, these are good sections of streams in which to collect watersnakes at night, since the water is shallow.

We have never seen the feeding method described by Evans (1942). He reports that the snake swims among groups, presumably schools, of fish, swinging its head from side to side and closing its mouth on coming in contact with a fish.

As a rule, the heads of prey in stomachs of watersnakes are directed toward the tail, which suggests that they are swallowed head first. This observation is substantiated by Clark (1903) and Brown (1940). Tooth marks that we have found on a brook trout (*Salvelinus f. fontinalis*) show, however, that prey may be grasped crosswise and manipulated until it can be engulfed.

The size of fish eaten varies greatly; usually they are small, but in rare instances one is taken which is remarkably large in relation to size of the predator. Clark (*ibid.*) records that a sizable specimen ate a sucker a foot in length. Sometimes prey too large to be completely swallowed or disgorged gets stuck in a watersnake and so causes its death. We have found that bullheads (*Ameiurus spp.*) very commonly do so. Their pectoral fin spines usually contribute to the death of snakes by puncturing the gut and body walls.

Single large organisms found in stomachs—usually also partly in the esophagus—were: a 7.75-inch and an 8.5-inch brown trout (*Salmo trutta fario*); a 7.38-inch brown bullhead (*Ameiurus n. nebulosus*); a lamprey (*Ichthyomyzon castaneus*), more than 8 inches long. Many small fish may be present in a stomach at one time; one specimen had 26 brook trout all approximately 2 inches long; another, 20 brook trout ranging from 1.25 to 1.50 inches in length. As might be expected, watersnakes from fish-rearing stations may each contain several to many fish, as noted in the previous statement, whereas those from natural waters average only a little more than one organism.

Food

Stomach contents alone were analyzed, since the advanced stages of digestion in the intestine make it almost impossible to identify items. Feces in the colon, however, do have recognizable materials. In one specimen the brown to black, semisolid amorphous mass contained fish-bone fragments, fish scales, and bits of insect chitin. General analytical methods employed are the precise qualitative and quantitative ones described by Salyer and Lagler (1940).

Remains of animals are, of course, utilized by this and other snakes. Carrion composed of fish was recognized in one specimen collected in a lake where the fish had just been experimentally poisoned, and snake exuviae were found in another specimen from elsewhere. We once watched a common watersnake take the viscera from several yellow perch (*Perca flavescens*) that were thrown to it at a fishery dock in Muskegon Lake. It is possible, then, that some of the animals recorded here as being in the food of the watersnake were dead when eaten; because of the characteristics of the material examined, we are confident that such incidence is small and of little significance. Moreover, the scavenging of crayfish and certain small fish that are abundant in Michigan, particularly in streams and shallow lakes, rapidly removes ordinary numbers of dead fish.

Most of the thirteen fish-cultural stations on which we are making reports are in the northern part of the Lower Peninsula; at these places large numbers of trout are held in raceways or ponds. For the most part these rearing enclosures are in, or adjacent to, natural trout streams. In them advanced fry to fingerlings are the available prey during summer months. Both their small size and their large numbers particularly expose them to predation.

Sixty-four watersnakes taken at these stations contained some food, but twenty-eight (43.8 per cent) had not recently eaten fish of the species being propagated. It is not necessarily true, however, that these snakes (which are listed separately in Table II, section B)

TABLE II

FOOD OF THE COMMON WATERSNAKE AT TROUT-REARING STATIONS

Based on 64 specimens containing 514.0 c.c. of food.

Food item	A		B		C	
	Food of those snakes (36) which contained trout		Food of those snakes (28) which did not contain trout		Food of all snakes (64) taken at rearing stations	
	Percentage by volume	Percentage of frequency of occurrence	Percentage by volume	Percentage of frequency of occurrence	Percentage by volume	Percentage of frequency of occurrence
Trout	79.4	100.0	..	..	48.9	56.3
Bass or sunfish.....	..	..	Trace	3.6	Trace	1.6
Forage fishes	20.4	16.7	81.5	57.1	44.0	34.4
Other fishes .	..	..	9.9	10.7	3.8	4.7
Fish remains	0.1	5.6	3.4	28.6	1.4	15.6
Amphibia ...	..	..	3.0	7.1	1.1	3.1
Insecta	..	..	1.4	7.1	0.5	3.1
Miscellaneous invertebrates	..	..	0.8	10.7	0.3	4.7

Annotated list of food items. — The following items were identified in the food of the 28 snakes which did not contain trout and are representative of the food in trout-stream habitats. LAMPREYS: 1 petromyzonid; 4 American brook lampreys (*Entosphenus lamottenii*). SUCKERS: 1 catostomid. MINNOWS: 3 cyprinids; 1 northern creek chub (*Semotilus a. atromaculatus*), 3.5 inches long; 2 western blacknose dace (*Rhinichthys atratulus meleagris*); 1 Great Lakes longnose dace (*Rhinichthys c. cataractae*). MUDMINNOWS: 2 western mudminnows (*Umbra limi*), each 3 inches long. DARTERS: 1 central Johnny darter (*Boleosoma n. nigrum*), 1.25 inches long. MUDDLERS: 11 identifiable only as *Cottus sp.* and ranging in length from 2 to 4 inches; 6 northern muddlers (*C. b. bairdii*) from 3 to 6 inches long. BURBOT: 3 burbots (*Lota lota maculosa*) with lengths of 3.5, 4, and 7 inches. FROGS: 1 frog (*Rana sp.*) and 1 tadpole of the green frog (*Rana clamitans*). INSECTS (1 each): Lepidoptera larva, *Isogenus sp.* larva, *Tabanus sp.* larva, grasshopper, *Moriomorum minitum*, and stonefly nymph. These were taken directly and are not from the stomach of some other organism eaten by the snakes. MISCELLANEOUS INVERTEBRATES: 2 snails, *Lymnea sp.*, 1 millepede, 1 earthworm.

had not fed in the rearing enclosures. It is also possible that some of the trout in these snakes may have been captured in neighboring wild waters, but our other data show that their number is small, and hence they are disregarded in our calculations. A parallel problem exists for the forage fishes, since they occur both in the rearing enclosures and in the adjoining natural streams. In fact, such fishes sometimes become quite abundant in the rearing ponds, presumably as a result of the artificial feeding of the small trout that are concentrated in these waters.

The numbers and sizes of the trout eaten by thirty-six watersnakes at rearing stations are as follows (total lengths are given and are based on actual measurements of whole fish or on careful estimates made by comparing parts of fish with whole specimens): largest, 8.5 inches; smallest, 1.0 inch; average length (based on 154 fish), 1.9 inches; total number found, 159; greatest number eaten by one snake, 26; average number eaten by each snake that contained trout, 4.4; average number for all watersnakes collected at these stations, 2.5.

Four conclusions may be drawn from these data: (1) Fingerling trout are easy prey; (2) Trout larger than 8.5 inches are vulnerable, since the snake which contained a specimen of this size was only 38 inches long, and larger sizes are attained; (3) A loss of five fingerling trout may be assumed for every two watersnakes collected on the premises of rearing stations during the proper season; (4) Control of watersnakes on fish-rearing waters is justified.

The natural waters from which specimens are here reported are of only two types — inland lakes and trout streams. Food habits of eighteen individuals in and about inland lakes show that nongame fishes and amphibians compose the bulk of the food and are eaten most frequently (Table III). Unfortunately, the number of snakes on which this is based is small. Brown's findings (1940) for specimens mostly from Douglas Lake, Cheboygan County, Michigan, include the following food items from waters of this kind and strengthen our data: common shiner (*Notropis cornutus*); spottail shiner (*Notropis hudsonius*); northeastern sand shiner (*Notropis deliciosus stramineus*); bluntnose minnow (*Hyborhynchus notatus*); brown bullhead (*Ameiurus nebulosus*); western mudminnow (*Umbra limi*); burbot (*Lota maculosa*); troutperch (*Percopsis omiscomaycus*); yellow perch (*Perca flavescens*); northern logperch (*Percina caprodes semifasciata*);

central Johnny darter (*Boleosoma n. nigrum*); muddlers (*Cottus bairdii*); mudpuppies (*Necturus maculosus*); leopard frogs (*Rana pipiens*); green frogs (*Rana clamitans*); wood frogs (*Rana sylvatica*); various tadpoles. The only food-fish records included are for the brown bullhead and the yellow perch. Langlois (1925) found fish in two specimens from the same region and a leopard frog in another. Summarily stated, the food of the watersnake on natural waters in Michigan (and New York) is about 80 per cent fish and 20 per cent amphibians (Brown, 1941). These percentages approach those for our material from wild conditions (Tables III–IV).

TABLE III

FOOD OF THE COMMON WATERSNAKE ON MICHIGAN LAKES

Based on 18 individuals containing 253.8 c.c. of food.

Food item	Percentage composition by volume	Number of individuals of each food item	Number of watersnakes containing each food item	Percentage frequency of occurrence
Game and pan fishes	19.3	2	2	11.1
Forage fishes	23.4	19	8	44.4
Other fishes	2.9	5	3	16.7
Fish remains	1.8	2	2	11.1
Frogs and salamanders	52.6	6	6	33.3
Rodents	Trace	1	1	5.6

Annotated list of food items. — FISHES: 1 sunfish; 1 common bluegill (*Lepomis m. macrochirus*), 1.25 inches long; 1 northern brown bullhead (*Ameiurus n. nebulosus*), 7.4 inches in length; 1 madtom (*Schilbeodes sp.*); 1 northern common shiner (*Notropis cornutus frontalis*), 4.25 inches; 1 blackchin shiner (*N. heterodon*), 2.5 inches; 1 northern blacknose shiner (*N. h. heterolepis*); 1 shiner (*Notropis sp.*); 1 hornyhead chub (*Nocomis biguttatus*), 4 inches; 1 northern creek chub (*Semotilus a. atromaculatus*), 3 inches; 1 bluntnose minnow (*Hyborhynchus notatus*); 1 unidentified cyprinid; 1 mudminnow (*Umbra limi*), 2.5 inches; 2 Johnny darters (*Boleosoma nigrum*), 1.8 and 1.9 inches; 1 Great Lakes muddler (*Cottus bairdii kumlieni*); 1 eastern burbot (*Lota lota maculosa*). FROGS: 1 leopard frog (*Rana pipiens*); 1 green frog (*R. clamitans*); 1 undetermined frog (*Rana sp.*). SALAMANDERS: remains of 1 unidentified salamander; 2 mudpuppies (*Necturus maculosus*). RODENTS: traces of one small rodent.

Since our eighteen specimens from lakes are from fifteen different bodies of water, it is not surprising that a wide variety of fishes is

TABLE IV

FOOD OF THE COMMON WATERSNAKE ON MICHIGAN TROUT STREAMS

Based on 106 individuals containing 707.6 c.c. of food.

Food item	Percentage composition by volume	Number of individuals of each food item	Number of watersnakes containing each food item	Percentage frequency of occurrence
Trout	19.0	9	7	6.6
Lampreys	3.3	9	7	6.6
Forage fishes ...	55.8	108	77	72.6
Fish remains ...	0.2	5	5	4.7
Burbot	7.3	3	3	2.8
Frogs	12.8	9	8	0.9
Miscellaneous invertebrates..	1.6	7	6	5.7

Annotated list of food items. — FISHES: 3 trout unidentified to species, 2.8, 3.0, and 3.3 inches; 4 common brook trout (*Salvelinus f. fontinalis*), 1.5, 1.5, 4.8, and 6.3 inches; 2 unidentified lampreys, 3.1 and 4.1 inches; 5 American brook lampreys (*Entosphenus lamottenii*), nonparasitic, 3.5, 4.0, 4.0, 4.2, 4.5, and 4.8 inches; 1 chestnut lamprey (*Ichthyomyzon castaneus*), parasitic on fish, 8.0 inches; 3 undetermined catostomids averaging 4.7 inches (4.5, 4.75, 4.75); 13 common white suckers (*Catostomus c. commersonnii*) averaging 2.2 inches and ranging from 1.6 to 2.5 inches for 11 specimens, the lengths of which were determined; 1 unidentified minnow; 2 northern creek chubs (*Semotilus a. atromaculatus*), of which 1 was 1.8 inches long; 1 northern pearl dace (*Margariscus margarita nachtriebi*), 4 inches; 1 hornyhead chub (*Nocomis biguttatus*), 3.5 inches; 3 western blacknose dace (*Rhinichthys atratulus meleagris*), 1.5, 3.0, and 3.5 inches; 2 Great Lakes longnose dace (*Rhinichthys cataractae*), 3.4 and 3.8 inches; 1 northern redbelly dace (*Chrosomus eos*), 2.0 inches; 1 northern common shiner (*Notropis cornutus frontalis*), 4.3 inches; 5 mudminnows (*Umbra limi*), 2.5, 2.5, 2.6, 3.5 inches (4 individuals); 1 undetermined darter, 1.5 inches; 10 northern logperch (*Percina caprodes semifasciata*), 3.1, 3.3, and 4.0 inches (3 individuals); 80 muddlers (*Cottus sp.*), of which 9 were slimy muddlers (*C. cognatus*) and 32 were northern muddlers (*C. b. bairdii*) averaging 3.4 inches for 71 that were treated for length; 3 eastern burbot (*Lota lota maculosa*), 5.0, 7.0, and 9.1 inches. FROGS: 3 unidentified frogs (*Rana sp.*); 2 bullfrogs (*R. catesbeiana*); 1 leopard frog (*Rana pipiens*); 1 green frog (*R. clamitans*); and 1 wood frog (*R. sylvatica*). INSECTS: 1 dragonfly nymph. MISCELLANEOUS INVERTEBRATES: 4 earthworms; 1 leech; 1 snail. These invertebrates were eaten directly and were not from the stomach contents of some other organism; all except the snail were the sole items of food in the stomachs in which they were found. The absence of crayfishes from the food of the common watersnake is puzzling, since they abound in trout streams, are quite nocturnal, and are of sizes which could be readily captured and swallowed by the snake.

represented. Kinds ordinarily eaten by man are represented only by the common bluegill and the brown bullhead. Furthermore, the burbot and the mudpuppy, which are preyed upon by this snake, usually are not considered assets to game-fish production.

The data from trout-stream watersnakes are striking and significant (see Table IV). Of the 106 individuals that contained food only seven (6.6 per cent) had captured trout. They contained but nine, an average of 1.28. The largest trout was 3.8 inches long; the smallest, 1.5 inches. The average length of the nine trout was 3.8 inches. It seems that if only seven to eight of every hundred snakes that are seen on a trout stream in a day contain trout, the harmful effects of this predator may be less serious than generally supposed. This can be tested by a hypothetical case. It is possible to make a population estimate for such streams as Bear Creek and Platte River. The average of the numbers observed for these two streams is about twenty per mile, but the repeated collections on Bear Creek suggest that only a part, probably a small one, of all inhabitants is seen at one time. Therefore, let us assume a population of one hundred in a mile. On this basis, the average loss of fingerling trout to watersnakes could be nine per mile each day or something more than a thousand for such a unit of length in a season (approximately four months). Such consumption may or may not be harmful to angling in any particular stream, but it is significant that if such a stream is to be stocked, the current procedure of planting trout seven or more inches in length would be desirable since such fish are about twice as long as the average size of fish most commonly taken.

Equally striking is the predominance of forage fishes in the watersnake food on trout streams. The great majority of these were muddlers; there was a total of 80 specimens in 60 snakes (56.6 per cent of all), and they composed 37.7 per cent of the total volume of food.

CONCLUSION

Because of the large number of factors determining production of fish per unit of area or of length on trout streams, it is impossible to state in any simple way, even with the aid of data as trenchant as these, the effect of predation by the watersnake (or by other fish predators). Some of the critical and determining variables, many of which are individual for each stream or parts of it, are: (1) existing

populations of the predators and prey and their trends; (2) daily food requirements and kinds and amounts of food eaten by predators; (3) direct effects of predation on populations of preferred species; (4) indirect effects of predation by increasing, decreasing, or offering competition for food or space; (5) related effects of any particular predator which also feeds on other predators; (6) culling effects of predation; (7) total effects of all predators in competition in any one habitat. Our information sheds a little light on each of these problems but not enough on any one. Clearly, however, the principal food of the common watersnake on Michigan trout streams is not trout, but other fishes. Any widespread control on natural waters, as in West Virginia (Netting, 1939) or as in Pennsylvania since 1933 (French, 1938; Sweigart, 1939; anonymous author, 1938), cannot be warranted biologically at this time. We are in general agreement, however, with the opinion of several workers, including Brown (1936) and Netting (1938), that reduction of populations at fish-cultural stations is requisite and justifiable.

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A REVISION OF THE NEARCTIC SPECIES OF *XYLOMYIA* AND *SOLVA* (DIPTERA, ERINNIDAE)

GEORGE C. STEYSKAL

THE forms here treated have hitherto been separated nearly entirely upon color characters. They have been considered generally members of a single genus, variously referred to as *Xylomyia* or *Solva*, although Malloch (1917, p. 341) and Leonard (the latest revision, 1930, p. 43) have both expressed the opinion that *X. pallipes* might not be congeneric with the other species.

The writer hopes to show that the species are parts of two distinct genera and that they are separable upon structural as well as definite color characters. He also wishes to demonstrate that the *X. tenthredinoides* of Leonard is a complex of three species, *X. tenthredinoides*, *X. pallidifemur*, and *X. simillima*, the last hitherto undescribed.

Enderlein (1922, p. 166) arranged the genera of the "Solvini" in the following key, to which the names of the generitypes have been added.

Hind femur broadened and thickened, with small teeth below
- Wing veins M_3 and Cu_1 connected near their bases by a crossvein or at most touching at a point
  - M_3 not shortened; third antennal joint somewhat longer than the others but not strongly thickened — *Hanauia* End. (*marginata* Mg., Europe)
  - M_3 strongly shortened; third antennal joint large and thick — *Subulonia* End. (*truncativena* End., Costa Rica)
- M_3 and Cu_1 near their bases fused for a distance, M_3 not shortened — *Solva* Walker (*inamoena* Wlk., Orient)

Hind femur not thickened and without small teeth below
- Antennal flagellum 8-segmented, the first segment not enlarged — *Xylomyia* Rondani (*maculata* Mg., Europe)
- Antennal flagellum 4- or 5-segmented, the first segment large and thick — *Bolbomyia* Loew (*nana* Lw., North America)

In this scheme the majority of our species run to the genus *Xylomyia*. *X. pallipes* and two species described by Hull (1945)

make the differences between *Hanauia* and *Subulonia* seem to be of degree only, and the notes by Lindner (1938) make both these genera seem to be synonyms of *Solva* Walker, the prior name. The character of the truncate third median vein is at least indicated in *X. pallipes* by a distinct apical weakening of that vein and is well shown in *S. crepuscula* Hull, where that of the fusion of M_3 and Cu_1 is also indicated.

Our two genera may be distinguished as follows:

Hind femora swollen and furnished beneath with minute teeth; flagellum of antennae with the joints distinctly although but slightly separated, the terminal joint twice as long as the preceding one, with a short but distinct conical bare shining tip, the first joint sometimes considerably enlarged; the second abdominal tergite membranous medianly except at posterior margin, allowing itself to fit closely to the metanotum when the abdomen is greatly upflexed; wings with at least one branch of the media not reaching margin, crossvein m-cu very short or absent; all veins microsetate above ..... *Solva* Walker

Hind femora not markedly thicker than the others and lacking teeth below; flagellum with the joints apparently fused, the first joint never enlarged; the second abdominal tergite not membranous anteromedianly; wing with all branches of media strong and reaching margin, crossvein m-cu well developed; wing veins posterior to radius not microsetate
Xylomyia Rondani

KEY TO THE NEARCTIC SPECIES OF THE GENUS *XYLOMYIA*

1. Wings dusky, a more distinct band at middle and tip; abdomen black with apical half of first four segments yellow; length approximately 10 mm. (Indiana; not recognized since the description in 1829)
X. fasciata Say

Wings clear 2

2. Terminal joint of antennal flagellum bare or nearly so; palpi more or less pointed (Figs. 6–7); scutellum practically entirely black or dorsum of thorax with paired median longitudinal yellow stripes 3

Flagellum bare except terminal joint, which has many coarse black hairs; palpi obtuse at tip (Figs. 3–5, 8); thoracic dorsum black or dark reddish centrally, without paired yellow median stripes; scutellum conspicuously yellow at tip 4

3. Scutellum and coxae practically wholly black; lateral margins of presutural area of mesonotum broadly yellow; terminal joint of flagellum slightly longer than preceding joint, tapering to a very short mucro (northwestern) ..... *X. parens* Will.

Scutellum with conspicuous yellow tip; coxae largely or wholly yellow; mesonotum with a pair of narrow yellow parallel dorsocentral stripes extending backward to level of wing bases; humeri and a spot at each end of the transverse suture yellow; terminal joint of flagellum subequal in

length to the preceding joint, bearing a slender mucro about half as long as the joint (widespread but scarce west to Wyoming)
X. americana Wied.

4. Distal half or third of hind femora and distal half of hind tibiae *saturate* black, strongly contrasting with the yellow proximal portion, or hind femora wholly black; terminalia reddish or black 5
Distal portion of hind femora and tibiae piceous to yellow, or femora wholly yellow to reddish yellow; terminalia reddish 6

5. Palpi usually blackish and with many black hairs; terminalia black; pteropleura black; hind femora wholly black in female and black on distal half in male (northeastern) ..... *X. aterrima* Johnson
Palpi wholly yellow, all hairs white or yellowish; pteropleura largely pale; hind femora in both sexes black on distal third; terminalia reddish, those of the male as in Figure 2,[1] the process *E* ligulate, extending to the margin of the broad flat cerci (*C*) (Wis., type; Pa., Mich., Ohio, Ill.)
X. tenthredinoides V. d. W.

6. Hind femora piceous to brown on distal two fifths (often distinctly paler toward tip) and hind tibiae brown on distal three fifths, the proximal portions of each yellow; palpi (Fig. 3) short, yellow, in the female usually with a blackish medial band, all hairs pale; terminal joint of flagellum not or but little longer than the preceding joint, mucro very short or indistinguishable; hind basitarsi less than 0.6 the length of the hind tibiae, pale yellow; pleura yellow, with a black spot above fore coxae and a black band from root of wing to hind coxae (pteropleura largely black or piceous in both sexes); male terminalia as in Figure 1 (*holotype*, male, and *allotype*, female, Nottawa, St. Joseph Co., Michigan, May 30, 1941 [G. Steyskal], in UMMZ; *paratypes*, Pa., Mich., Ohio, Ill., Tenn., as listed below) ..... *X. simillima*, sp. nov.

Hind femora wholly yellow to reddish, at most diffusedly blackish on distal sixth; hind tibiae yellow to reddish, at most black at the extreme tip, the proximal sixth distinctly white, which portion may be set off distally by a band slightly darker than the rest of the tibia; palpi (Fig. 5) yellow, strongly swollen in the female and extending forward to the level of the root of the antennae, in the male much shorter and little swollen, sometimes subulate and obliquely truncate; palpal hairs largely pale, but a few dark hairs may be present; terminal joint of flagellum usually about 1.5 times as long as preceding joint, mucro much longer than surrounding hairs, distinct; hind basitarsi more than 0.65 the length of the tibiae, white; pleura in female usually mostly black, in male much as in species above (pteropleura black in female, largely yellow to wholly black in male); female frequently lacking the lateral yellow spots on metanotum; male terminalia with process A as in Figure 9 (widespread in east) ..... *X. pallidifemur* Malloch

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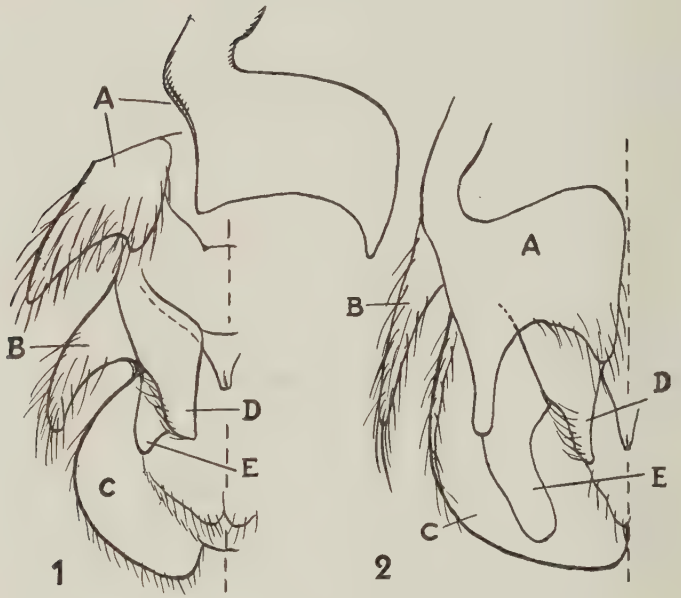
[1] Inasmuch as the terminology of the parts of the male terminalia is still unsettled and especially since the homologies of those of *Xylomyia* species are not clear, letters are used to designate corresponding parts in Figures 1–2.



Xylomyia simillima, sp. nov. *Xylomyia tenthredinoides* V. d. W.

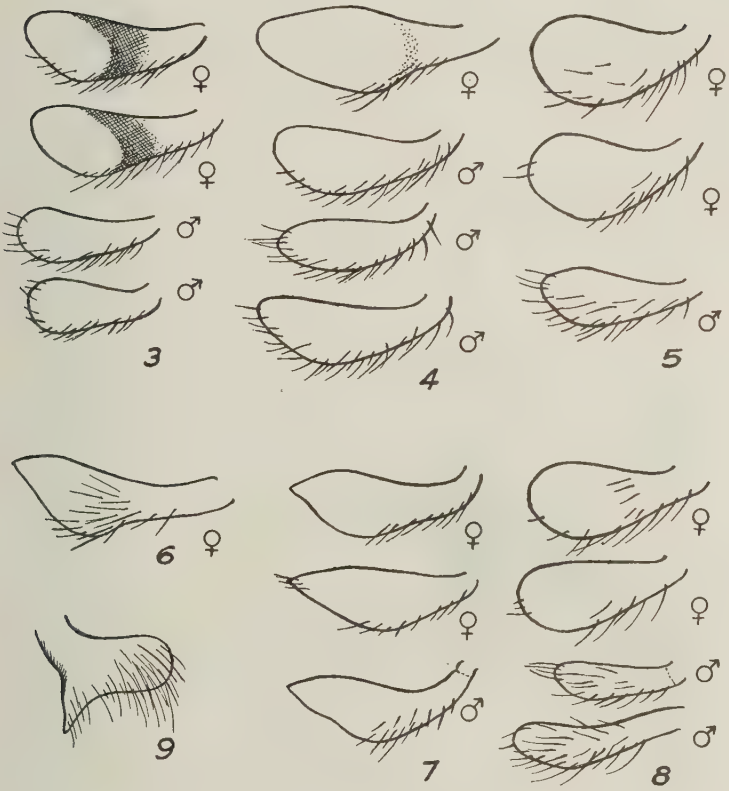
FIGS. 1–2. Ventral views of right half of male terminalia of *Xylomyia* species. Corresponding parts are indicated with the same letters

KEY TO THE NEARCTIC SPECIES OF THE GENUS *SOLVA*

1. Wing vein M_3 failing by nearly half its length to reach margin; abdomen black, lacking pale posterior segmental margins (Miss.) *S. crepuscula* Hull
   M_3 reaching margin of wing or at least junction with Cu_1 near margin; abdomen with narrow pale posterior segmental margins 2
2. Palpi dark brown with black tip (Miss.) ..... *S. pygmaea* Hull
   Palpi wholly pale yellow (widespread and common throughout nearctic region) ..... *S. pallipes* Loew

NOTES AND DISTRIBUTIONAL RECORDS

Extended description of *Xylomyia* species is considered unnecessary since all the constant differences that the writer can discern are given in the key and figures. Bibliography of the species may be found in Leonard (1930) or in the Aldrich *Catalogue* (1905).



FIGS. 3–8. Profiles of left palpi of *Xylomyia* species

FIG. 3. *X. simillima*, sp. nov.
FIG. 4. *X. tenthredinoides* V. d. W.
FIG. 5. *X. pallidifemur* Mall.
FIG. 6. *X. parens* Will.
FIG. 7. *X. americana* Wied.
FIG. 8. *X. aterrima* Jns.

FIG. 9. *X. pallidifemur* Mall., process *A* of male terminalia (cf. Figs. 1–2)

Genus XYLOMYIA Rondani

Subula Meigen, Syst. Beschr., 2: 15. 1820. Preoccupied.
Xylomya[2] Rondani, Dipt. Ital. Prodr., 4: 11. 1861.

Xylomyia americana Wied. (Fig. 7, palpi). — The following specimens have been examined: New York: Ithaca, ♀, July 12, 1918, in INHS;[3] ♀, Aug. 13, 1928 (R. C. Osburn), in OSU; Pennsylvania: Delaware County, ♀, June, in MCZ; District of Columbia: Washington, ♂, June 9, 1925, on window (J. A. Stevenson), in USNM (*teste* M. T. James); North Carolina: Raleigh, ♂, June 2, 1904 (F. Sherman), in USNM (*teste* M. T. James); Georgia: Atlanta, ♀, June 26, 1942 (P. W. Fattig), in USNM (*teste* M. T. James); Michigan: Detroit, ♀, July 23, 1944 (G. Steyskal), in GS; East Lansing, ♀, Aug. 23, 1937 (F. Parmelee), in MSC; Ohio: Put-in-Bay, S. Bass Id., ♀, June 20–30, 1924, in OSU; Columbus, ♂, June 8, 1906, in OSU; Indiana: Elkhart, ♂, in MCZ; Lafayette, ♂, July 13, in USNM; Illinois: "Ill. / Am. Ent. Soc. Collection," ♀, in USNM (*teste* M. T. James); "N. Ill.," ♂, in INHS; Shawneetown, ♀, June 14, 1934 (Ross and DeLong), in INHS; Urbana, ♀, June 17, 1914, in INHS, ♀, June 20, 1932 (Frison), in INHS; Willow Springs, ♀, June 24, 1906 (E. Liljeblad), in UMMZ; Mississippi: "Miss.," ♀ (J. M. Aldrich), in USNM (*teste* M. T. James); Missouri: Joplin, in park, ♀, May 31, 1942 (A. B. Gurney), in USNM; Kansas: Fort Riley, ♀, June 26, 1932 (F. M. Carpenter), in MCZ; Texas: "Texas," ♀ (Belfrage), in USNM (*teste* M. T. James); Wyoming: "Wyo., 1881," ♂ (Morrison) in USNM (*teste* M. T. James).

Xylomyia aterrima Johnson (Fig. 8, palpi). — The following specimens have been examined: New Brunswick: Nerepis, ♂, July 22 (A. G. Leavitt), in USNM (*teste* M. T. James; cited in Leonard [1930] as *X. tenthredinoides*); Ontario: Ottawa, ♀, in USNM (*teste* M. T. James); Pennsylvania: "Pa., 1572, Collection Coquillett," ♀, in USNM (*teste* M. T. James); Pittsburgh, ♂ (G. A. Ehrman), in USNM (*teste* M. T. James); Virginia: Falls Church, ♂, June 22 (N. Banks), in MCZ, ♂, June 12, 1939 (J. P. E. Morrison), in USNM; Glencarlyn, ♀, May 30 (N. Banks), in MCZ; Michigan: Ann Arbor, ♀, June 28, 1920 (T. H. Hubbell), in UMMZ; Detroit, ♂, June 11, 1939, ♀, June 16, 1940 (G. Steyskal), in GS; Douglas Lake, ♀, July 1, 1931 (C. W. Sabrosky), in CWS, ♀, July 18, 1940 (D. Copeland), in KU; Lapeer County, ♀, July 4, 1937 (G. Steyskal), in GS; Oak-

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[2] The form *myia* ("fly"), although an emendation of the form regularly used by Rondani, is preferred by the writer for the sake of uniformity with the many other generic names in Diptera having the ending *-myia*.

[3] Designations of depositories have been abbreviated as follows: ANSP, Academy of Natural Sciences of Philadelphia; CWS, collection of Curtis W. Sabrosky; FMH, collection of Frank M. Hull; GS, the writer's collection; INHS, Illinois Natural History Survey; KU, Snow Entomological Museum, Kansas University; MCZ, Museum of Comparative Zoology, Harvard University; MSC, Michigan State College; OAES, Oklahoma Agricultural Experiment Station; OSU, Ohio State University; RRD, collection of Robert R. Dreisbach; UMMZ, University of Michigan Museum of Zoology; USNM, United States National Museum.

land County, ♂, June 22, 1935 (G. Steyskal), in GS; Ohio: Cincinnati, 3 ♂, 1 ♀, June 9–16, 1901, 6 ♂, 3 ♀, May 30–31, 1902, ♀, June 13, 1902, ♀, May 30, 1908, in OSU; Ira, ♂ (J S. Hine), in OSU; Illinois: Freeport, ♂, July 4, 1917, in INHS; Willow Springs, ♂, June 24, 1906 (E. Liljeblad), in UMMZ.

Xylomyia fasciata Say. — Leonard (1930, p. 40) gives the original description and a résumé of later discussion, to which nothing can be added now.

Xylomyia pallidifemur Malloch (Fig. 9, process *A* of male terminalia; Fig. 5, palpi). — The venational characters and that of head width used by Malloch have not been found practical. The following specimens, including the types and some of the material listed by Leonard (1930, pp. 47–48) under *X. tenthredinoides*, have been examined. Massachusetts: Bass Rocks, ♀, June 10, in ANSP; Beverly, ♂, July 10, 1866, in USNM; New York: Sacandaga, ♀, June 15, 1928 (C. P. Alexander), in USNM (*teste* M. T. James); Taughannock Falls, ♀, June 18, 1929 (R. Dean), in OSU; New Jersey: Wenonah, ♂, June 23, 1907, in ANSP; Pennsylvania: "Penn. / Collection Coquillett," ♂; Allegheny, ♂, June 27, 1891 (J. M. Aldrich), both in USNM; Castle Rock, ♂, June 3, 1906 (G. M. Greene), in USNM (*teste* M. T. James), ♂, June 14, 1908, ♀, June 13, 1909, ♀, June 19, 1910 (all G. M. Greene), in USNM; ♂, June 9, 1907, ♂, June 6, 1909, both in ANSP; Natrona, ♀, July 12, 1895, in MCZ; Roxborough, ♂, May 29, 1909 (G. M. Greene), in USNM (*teste* M. T. James), ♀, June 26, in ANSP; Swarthmore, ♀, June 11, 1905 (E. T. Cresson), in ANSP; Maryland: Cabin John Br., ♀, May 9, 1923 (J. M. Aldrich), in USNM; Glen Echo, ♀, (R. M. Fouts), in USNM; Plummer's Id., ♀, July 6 (N. Banks), in MCZ, ♀, at light, Aug. 3, 1915 (R. C. Shannon), in USNM; District of Columbia: "D.C. / Collection Coquillett," ♂; Washington, 3 ♂; Georgetown, ♂, ♀ (H. H. Smith), all in USNM; Virginia: Dead Run, Fairfax County, ♂, June 29, 1915 (R. C. Shannon); Difficult Run, ♀, July 7, 1915 (R. C. Shannon); Dixie Landing, ♂, July 4 (Townsend), all in USNM (the last *teste* M. T. James); Falls Church, ♂, June 7, 1914 (R. C. Shannon), in USNM; Potomac Creek, ♀, May 23, 1896, in MCZ; North Carolina: N. Fork Swannanoa, Black Mt., ♂, May, in MCZ; Georgia: Rabun County, ♀, July, 1910, in MCZ; Michigan: Detroit, ♀, June 11, 1939 (G. Steyskal), in GS; Douglas Lake, ♀, July 17, 1942 (C. W. Sabrosky), in CWS; Ohio: Cantwell Cliff, ♂, May 25, 1930, in OSU; Hinckley, Medina County, ♀, Aug. 17, 1904, in OSU; Ira, Summit County, ♀, in OSU; Illinois: "Ill. / Loew / *americana*," ♀, in MCZ; Herod, ♀, June 24, 1932 (Ross, Dozier, Park); Homer Park, ♀, June 30, 1927, at light (T. F. and R. G.); Savanna, ♂, June 13, 1917; Urbana, ♂ type, June 17, 1890, 2 ♀ types, June 1, 2, 1890 (C. A. Hart), all in INHS; Iowa: Ames, ♀, June 16, 1923, in OSU; Kansas: "Kans. / Subula parens Coq.," ♀, in USNM; Oklahoma: Flint, ♀, June 6, 1934 (A. E. Pritchard), in OAES; Locality?: "Loew / *american?* Wied.," ♂, in MCZ.

Xylomyia parens Williston (Fig. 6, palpus). — British Columbia: Vernon, 2 ♀, June 21, 1902, and July 4, 1902, in OSU; Utah: Eureka, ♀, April 11, 1910 (T. Spalding), in MCZ; Washington: "West. Wash. Ty.," ♀ (H. K. Morrison); Oregon: Astoria, ♀, July 19, 1931 (S. K. Zimmerman); California: Klamath Riv. near mouth, ♀, July 11, 1930 (J. M. Aldrich), all in USNM (*teste* M. T. James).

Xylomyia simillima new species (*vide supra*, in key; Fig. 1, male terminalia; Fig. 3, palpi). — *Holotype*, male, and *allotype*, female, Nottawa, St. Joseph County, Michigan, May 30, 1941 (G. Steyskal), in UMMZ; *paratypes*, males, same data, in ANSP, CWS, FMH, GS, MCZ, UMMZ, USNM, males and females, same data, in RRD. The following have also been labeled as paratypes. PENNSYLVANIA: Allegheny, 2 ♂, 1 ♀, in USNM; Castle Rock, ♂, June 1, 1902, ♀, June 16, 1904 (the latter collected by C. T. Greene), in MCZ, ♂, June 3, 1904, in OSU, 2 ♂, June 3, 1906 (G. M. Greene), in USNM; Pittsburgh, ♀, June 4, 1897, ♂, June 15, 1897 (both from J. M. Aldrich collection), in USNM; MARYLAND: Cabin John, ♂, June, 1917 (R. M. Fouts); Plummer's Id., ♂, June 8, 1902 (H. S. Barber), ♂, June 3, 1914 (R. C. Shannon), ♀, June 13, 1914 (R. C. Shannon), ♂, June 6, 1915 (R. C. Shannon), 2 ♂, June 12, 1918 (Schwarz and Barber), all in USNM; MICHIGAN (see also type data above): Nottawa, males, June 8, 1941 (C. W. Sabrosky), in CWS; Branch County, ♂, June 1, 1941 (R. R. Dreisbach), in RRD; Midland County, 2 ♀, June 20, 1940 (R. R. Dreisbach), in RRD; OHIO: Cincinnati, 2 ♂, 3 ♀, June 9–16, 1901, ♂, ♀, May 30–31, 1902, in OSU; Hocking County, ♂, May 23, ♀, June 1, 1938 (D. J. and J. N. Knull), in OSU; Ira, Summit County, ♀, July 1, 1920 (J. S. Hine), in OSU; ILLINOIS: Algonquin, ♀, June 9, 1895, in MCZ, 1 ♂, 3 ♀, June 13, 1895, "122," in INHS; Augerville, 2 ♀, June 6, 1915; Oakwood, ♀, June 15, 1930 (H. H. Ross); St. Joseph, 2 ♀, June 12, 1913; Urbana, ♂, May 19, 1899, pond grove (Hart Colln. 484), ♀, June 18, 1920 (H. H. Ross), 2 ♀, May 30, 1922 (Beardsley), all in INHS; White Heath, 1 sex indeterminate (abdomen missing), 1 ♂, 5 ♀, June 4, 1939, ♂, May 29, 1938 (all J. C. Dirks), all in INHS; TENNESSEE: Gatlinburg, ♀, June 23, 1940 (R. C. Osburn), in OSU.

Xylomyia tenthredinoides Van der Wulp (Fig. 2, male terminalia; Fig. 4, palpi). — This species has been identified on the basis of the statement in the original description "de spits der achterdijen voor ruim een derde deel en die der achterscheenen voor ruim de helft zwart, in welke kleur ook de sporen dezer scheenen deelen" (the tip of the hind femora about one third and that of the hind tibiae about half black, in which color the spurs of these tibiae also "partake"). The type, a female presumably in the Leyden Museum, was from "Wisconsin." The following material has been examined: PENNSYLVANIA: Allegheny, 2 ♀, in USNM (*teste* M. T. James); Ono, ♀, June 7, 1940 (Melander), in MCZ; Washington County, ♀, June 14, 1894 (Ehrman), in USNM (*teste* M. T. James); MICHIGAN: Ann Arbor, ♀, July 4, 1917 (E. G. Anderson), in USNM; East Lansing, ♂, June 9, 1936, in MSC; Lapeer County, Deerfield Township, ♀, July 4, 1936 (G. Steyskal), in GS; Monroe, ♂, July 4, 1940 (G. Steyskal), in GS; Oakland County, 2 ♂, June 22, 1935 (G. Steyskal), in GS; Washtenaw County, 2 ♂, June 1, 1939 (E. K.), in KU; Whitmore Lake, ♀, July 3, 1917 (E. G. Anderson), in USNM (*teste* M. T. James); WISCONSIN: Milwaukee, ♀, Aug. 10, in USNM (*teste* M. T. James); ILLINOIS: Charleston, ♂, June 7, 1931 (T. H. Frison), in INHS; Utica, 1 pair taken *in copulo*, June 21, 1929 (F. G. Werner), in MCZ; MINNESOTA: "Minn.," ♂, in USNM (*teste* M. T. James): Olmsted County, ♂ July, 1904 (C. N. Ainslie), in USNM.

Genus SOLVA Walker

Solva Walker, Proc. Linn. Soc. London, Zool., 4 : 98. 1860.
Subulonia Enderlein, Zool. Anzeiger, 42 : 545. 1913.
Hanauia Enderlein, in Brohmer, Fauna von Deutschland, Second Edition, p. 281. 1920.
Phloophila Hull, Entomol. News, 55 : 263 (as subgenus of *Solva;* type, *pallipes* Lw.). 1945.

Solva crepuscula Hull, *loc. cit.*, University, Mississippi. — A paratype female, kindly furnished by Professor Hull, exhibits the following characters in addition to those of the original description:

Front parallel-sided, wider than in *S. pallipes*, with a small patch of white pubescence anterior to ocellar triangle, thence bare and shining to a transverse band of white pubescence above insertion of antennae (in *S. pallipes* the whole front is covered with longish prostrate white pubescence). Antennae only as long as head and first joint of flagellum nearly twice as wide as fifth joint (in *S. pallipes* the antennae are half again as long as the head and the first flagellar joint is but slightly wider than the fifth). Wing vein M_2 evanescent shortly before margin, as in *S. pallipes*. M_3 and Cu_1 meeting at a point in one wing and fused for a very short distance in the other. Hind coxae black at base, otherwise largely piceous (in *S. pallipes* wholly pale yellow).

Solva pallipes Loew. — Apparently common throughout the nearctic region. See comparative notes under *S. crepuscula* and *S. pygmaea.*

Solva pygmaea Hull, Entomol. News, 55 : 264 (1945), female only, Oxford, Mississippi. — Professor Hull has graciously permitted examination of the holotype. It is very similar to *S. pallipes*, differing chiefly in smaller size (although the writer has males of *S. pallipes* equally small) and the apically darkened palpi. The palpi show evidence of having been wet and are closely appressed to the face. The terminal abdominal segments of females of *S. pallipes* may also be wholly black.

The writer wishes to express thanks to those who have so generously furnished material for this study and especially to Maurice T. James, who has given valuable criticism and supplied the records cited "*teste* M. T. James."

Detroit, Michigan

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